THURSDAY, DECEMBER 1, 1887.

THE MATHEMATICAL THEORY OF PERFECTLY ELASTIC SOLIDS.

An Elementary Treatise on the Mathematical Theory of Perfectly Elastic Solids; with a Short Account of Viscous Fluids. By William John Ibbetson, M.A. (London: Macmillan and Co., 1887.)

IT is strange that students should have had to wait till the present time for a systematic English text-book on the mathematical theory of elastic bodies. The want has been decidedly felt at Cambridge since the introduction of the subject into the schedule for the Mathematical Tripos in 1873; and though parts of Thomson and Tait's treatise on natural philosophy, and the reprint of Green's papers, had already brought a large amount of useful matter into an accessible form for those who had not time or opportunity to read the original memoirs, still it was found that learners, naturally looking for some compendious account of the whole subject, generally fell back upon M. Lamé's treatise.

The book at present under notice will supply this want satisfactorily. The plan on which it has been written is excellent in idea, and has on the whole been followed out well, though perhaps there is here and there some want of proportion, as for instance in the elaborate and purely mathematical details of Chapter V.

It is, no doubt, a difficult matter to decide what results of mathematical analysis should be introduced without proof in a treatise on mathematical physics, and there is little question that, as a matter of convenience to the reader, it is wiser to err on the side of assuming too little knowledge rather than too much. On the other hand, wherever questions of pure mathematics are introduced and discussed at length, they should be such as have a direct bearing on important parts of the physical subject. Now the general forms of the dynamical equations for an elastic body in terms of curvilinear co-ordinates, which are established in Chapter V. after a considerable amount of preliminary analysis, are so complicated as to be practically valueless. Indeed, the one case referred to is dismissed in a single paragraph. The special forms for polar and semi-polar co-ordinates, often to be used with advantage, may be very much more simply established independently.

To return to the general plan of the book. It commences with a short preliminary chapter, headed "Properties of Elastic Solids," in which, after showing that the subject cannot be profitably considered from the point of view of molecular structure, the author defines the ideal solid which must for purposes of analysis replace the real body.

In Chapter II. the general properties of strain are treated very clearly and at considerable length. A little more consideration might perhaps have been given with advantage to finite homogeneous strain. No fewer than three quadrics are introduced for the purpose of putting results into a geometrical form, viz. the strain ellipsoid, the elongation quadric, and the position ellipsoid; while in the succeeding chapter, on "The Analysis of Stress," four surfaces—the first, second, third, and fourth stress quadrics—are used for a similar purpose. It can hardly be doubted that so great a number of surfaces will tend rather to confusion than to that clearness of conception of the properties of strain and stress for which they are presumably introduced.

The nature and mode of specification of stress is carefully expounded in Chapter III., and the dynamical equations to be satisfied throughout the body and over the boundary are obtained in terms of the stress-components. Attention should be called to a statement in § 153 of this chapter, as likely to mislead the student. It is to the effect that "the component stresses are to be considered as small quantities of the first order." Though in a certain sense this is true, it is not true that the ratio of the stress per unit area to, say, the weight per unit volume of the body is a small proper fraction, and this surely is the strict sense the words should bear.

The next chapter, on "The Potential Energy of Strain," is excellent. The method is similar to that used by Thomson and Tait; and the successive simplifications introduced into the expression for the potential energy of the strained body by considering successively greater degrees of symmetry of structure, leading up to perfect isotropy, are well shown. It is also pointed out that from the definition of an isotropic body, its potential energy is necessarily a function of the invariants of the strain, thus reducing the number of independent elastic constants in this case at once to two. Having thus arrived at a definite conception of the isotropic elastic solid, the author expressly limits all the investigations that follow to the case of such a body. From the expression obtained for the potential energy, forms are deduced for the stress components in terms of the strain components and the elastic constants, and thence finally the dynamical equations are obtained in terms of the displacements.

In Chapter V., as already stated, these equations are thrown into new forms, and the remainder of the book is devoted to their solution under various conditions as to the nature of the applied forces and tractions and the form of the body.

As an introduction to the consideration of particular questions the following five general theorems are proved, viz.:—

"(i.) that a state of strain cannot be maintained unchanged without the action of applied forces or surface tractions:

"(ii.) that the state of strain maintained by a given system of equilibrating applied forces and surface tractions is therefore perfectly determinate:

"(iii.) that the most general free motion of an elastic solid consists of a number of superposed harmonic oscillations of the particles about their natural positions:

"(iv.) that the most general motion of such a body under the action of an equilibrating system consists of a number of superposed harmonic oscillations of the particles about the equilibrium positions that would be maintained by the system:

"(v.) that a system of applied forces varying as a simple harmonic function of the time gives rise to forced harmonic oscillations of the particles of the same period about their natural positions."

The proofs given of these theorems, and especially of the third, are rather unnecessarily long; but, with a view to avoiding repetition later on, it is certainly convenient

to have them established as a foundation from which to start.

The problem of free vibrations is first treated, and as an example the propagation of plane waves of (i.) normal, (ii.) tangential, displacement is investigated. It is a pity that the author has not here taken the opportunity of illustrating some previous remarks on the discontinuity of the forms of the strain and stress components which necessarily accompanies a change in the nature of the medium, by considering the question of the reflection and refraction of plane waves.

The general form of the solution of the equations for forced vibrations is next investigated. Then follows the general question of equilibrium. As a simple example the case of a cylindrical tube under external and internal normal pressures is first treated. It is almost annoying to find the solution of this time-honoured question obtained by starting from the general equations, and whittling them down till the very simple conditions are fulfilled. The equilibrium of a solid sphere, with either surface tractions or displacements given, is treated exactly as in Thomson and Tait's work. The chapter of general solutions closes with an account of Airy's general method for plain stress, with a couple of examples. The printing was unfortunately so far advanced that this had to be left; though before the book appeared the author had himself shown, in a communication to the London Mathematical Society, that these examples of Airy's are faulty, and that the method applies only to a very limited class of cases.

Chapter VII. consists mainly of a capital exposition of the solution of St. Venant's problems of the torsion and flexure of prisms. These problems are probably, from a practical point of view, the most important for which an exact solution has been obtained. The author brings out well the bearings of the nature of the solutions on practical questions of construction. The elastic equilibrium and small motions of wires, whether straight or curved, are deduced directly from the results of St. Venant's problems. In connection with this part of the subject, certain interesting questions of stability, due to Mr. Greenhill, are discussed.

Some cases of the equilibrium and vibrations of plates and shells are considered in Chapter VIII. For the equilibrium of a plate of uniform thickness under a system of surface tractions parallel to its faces and acting on its edges, a solution is obtained by analysis very similar to that used in St. Venant's problem. The case of a thin plate under the action of applied faces satisfying certain conditions is quoted from Thomson and Tait again.

Two short chapters headed "Impact" and "Viscosity" complete the volume. The former consists of the solution of two problems, one of which, as the author implies, has nothing to do with impulsive change of motion. Indeed, as is well known, the exact treatment of the impact of elastic bodies involves difficulties, even in comparatively simple cases, which have not yet been overcome. In the last chapter the alteration in the form of the dynamical equations is determined, which results from supposing the shearing stress to vary partly as the shear and partly as its rate of change.

Having thus given some account of the plan of the book and the way in which it has been carried out generally, we may offer some remarks on matters of detail. It may be said at once that as regards accuracy there is a good deal to be desired. The table of errata might have been tripled, and would not then have contained all the misprints. In §§ 299, 306, the wholesale omission of signs of summation in the equations makes the analysis, as given, incorrect; and there is little doubt but that anyone to whom the matter treated was new would be completely baffled. The inaccuracies, moreover, are not confined to mere misprints. There are one or two positive mistakes in the mathematics. Thus at the bottom of p. 58 it is implied that some condition is necessary in order that a family of surfaces, $f(x, y, z) = \xi$ (an arbitrary parameter), may have a system of continuous curves cutting them at right angles; and in a note at the foot of p. 298 it is stated that, supposing this (entirely imaginary) condition satisfied, two other systems of surfaces can always be found cutting each other and the former surfaces everywhere at right angles. Now the three parameters of such a triple system of surfaces have to satisfy three independent partial differential equations, and hence no one of the three can be taken arbitrarily. Statements and reasoning are, in several passages, founded on this erroneous conception. Closely allied with this is the construction given in § 216 for tubes of stress. It is here practically assumed that a given continuous system of curves can always be cut at right angles by a family of continuous surfaces.

An appendix at the end of Chapter II., on "The Geometry of Strains," might have been omitted with advantage. It has no very obvious connection with the preceding chapter, but is devoted to an apparently new classification of vector quantities, in which a velocity and a force are the types of the one group, while an angular and a couple are those of the other! Again, in §§ 270, 271, the solution of a physical problem is made to appear to depend on the choice of an origin. The question treated is the free normal vibrations of a plate; and, after using d and $-d'$ to denote the abscissæ of the two faces, and making the result appear to depend on d/d', the question is *simplified* by taking the origin midway between the faces. Indeed, frequently throughout the book one is reminded of Clerk Maxwell's remark on "the state of a mind conscious of knowing the absolute position of a point."

These slips, such as they are, and an occasional obscurity of language, are but slight blemishes on a valuable book. A friendly but independent criticism of the proof-sheets while the book was passing through the press might have removed them all, and no doubt will in a new edition.

The figures throughout are excellent.

THE VOLCANIC AND CORAL ISLANDS OF THE SOLOMON GROUP.

The Solomon Islands: their Geology, General Features, and Suitability for Colonization. By H. B. Guppy, M.B., F.G.S., late Surgeon R.N. (London: Swan Sonnenschein, Lowrey, and Co., 1887.)

SURGEONS in Her Majesty's navy are favoured beyond most men in the possession of abundant leisure and freedom from many of the common cares of

life. But in spite of the frequent changes of scene which they enjoy, or endure, and their unique opportunities for pursuing scientific researches, and in spite of their early acquaintance with elementary treatises on several branches of science, it is only at rare intervals that naval surgeons appear as observers or investigators. The unusual occasionally happens, and in the work by Mr. Guppy on the Solomon Islands we have an admirable example of what may be accomplished by an energetic observer alive to his advantages.

In this volume it would not be difficult to point out many imperfect forms of expression, some avoidable confusion in arrangement, even a few conclusions that the facts hardly appear to warrant; but these sink into insignificance when compared with the mass of valuable material from which they might be culled.

The object of the book is to describe fully, but in a general way, the author's geological observations on the islands of the Solomon Group, little space being devoted to the other subjects mentioned in the title. It is a compendium of important facts, most of them new to the scientific public. Perhaps the Journal of the Geological Society is hardly suited for recording a series of laborious and detailed observations on the rocks of a remote archipelago, and the publications of the Royal Society of Edinburgh—where detailed papers by Mr. Guppy appear —may not be read by all geologists. It may not be inappropriate, in these circumstances, to mention a few of the facts observed by Mr. Guppy and recorded in this volume.

The book is divided equally between the description of volcanic and calcareous islands, and is illustrated by maps and sections.

The volcanic rocks collected on the islands were submitted for mineralogical analysis to Prof. Judd and Mr. T. Davies; the calcareous formations were studied by Mr. John Murray; and the remains of animal life, both foraminiferal and coral, are being examined by the leading specialists; hence the work is enriched by the labours of well-known men, and the "gold" of the author's data impressed with the "guinea-stamp" of recognized authority.

The volcanic islands of the group are divided into two classes. First, those of comparatively modern formation, composed mainly of little-altered augite-andesites, andesitic pitchstones, tuffs, and agglomerates: these islands still preserve the volcanic outline and sometimes give evidence of recent activity by terminating in craters with hot springs or fumaroles. The second class is composed only in part of these rocks, and in part of much more ancient crystalline masses consisting chiefly of altered dolerites, quartz-diorites and -porphyries, and serpentines. Some islands of the latter class exhibit an extraordinary diversity in petrological character. Fauno, the description of which is illustrated by a geological map, is an interesting instance of this. The northern end of the island is occupied by a precipitous mountain of andesitic tuff sloping steeply down from an altitude of 1900 feet to a narrow isthmus, 150 feet high, composed of hornblende-augite-andesite, and leading to a sickle-shaped peninsula of successive hills connected by low strips of rock. The composition of this crescentic tongue is successively altered dolorites, quartz-porphyries, quartz-andesites, hornblende-andesites, and altered dolerites again. These rocks, almost invariably massive and unassociated with tuffs or agglomerates, each in turn occupy the whole breadth of the peninsula. The mode of formation which Mr. Guppy demonstrates for this promontory is illustrated in various stages by several other islands. A series of small volcanoes arising in a crescentic form, and each pouring out a characteristic lava, were gradually elevated and so brought into connection. Rapid denudation, caused by the great rainfall of the region, wore off the volcanic contours and reduced the chain of peaks to a series of "necks" in close juxtaposition. The comparative rarity of fragmental volcanic rocks, and the mineralogical constitution of the massive crystalline lavas of the surface, indicating their solidification at great depths, prove extensive denudation to have taken place all over those islands.

The main interest of the book centres in the researches of Mr. Guppy on calcareous deposits. He is the only geologist who has visited this most instructive group of coral islands; and he describes what he saw there with a straightforward simplicity that compels confidence in the accuracy of his observations, and affords to those who may find his theory insufficient all possible data for disproving it.

Mr. Guppy gives the following classification of the limestones of a "coral island" in the Solomon Group as revealed to him by the walls of the river gorges he explored:—

Group I.—*Coral Limestones*, properly so called.

Group II.—*Coral Limestones* which have the composition of coral muds or sands now forming near coral reefs. There are three subdivisions of this group: (1 crystalline limestone, in which coral plays a secondary part, and remains of calcareous Algæ and mollusks predominate; (2) chalky limestones; (3) homogeneous fawn-coloured limestones, often crystalline.

Group III.—*Rocks of the composition of volcanic mud and pteropod ooze*, containing also numerous Foraminifera. These are subdivided into (1) partially consolidated volcanic muds; (2) partially consolidated pteropod ooze; (3) hard limestones.

Group IV.—*Foraminiferal Limestones*, or consolidated "Globigerina ooze." There are two classes: (1) composed chiefly of tests of both pelagic and bottom-living Foraminifera; (2) chiefly composed of the tests of pelagic Foraminifera.

Group V.—*Rock resembling a consolidated deep-sea clay* (Red Clay).

The two last-named groups were certainly deposited at depths not much less than 2000 fathoms in an ocean far from continental land, and their existence above sea-level is now for the first time proved.

From all the facts that could be ascertained regarding the coral formations of the group, certain inferences were drawn, which we give in the author's own words:—

"The first is self-evident, viz. *that these upraised reef masses, whether atoll, barrier reef, or fringing reef, were formed in a region of elevation.* . . . It is apparent that Mr. Darwin's theory of coral reefs, which ascribes atoll and barrier reefs to a movement of subsidence, cannot be applied to the islands of the Solomon Group. . . .

"The second inference is, *that such upraised reefs are of moderate thickness, their vertical measurement not exceeding the usual limit of the depth of the reef-coral zone*

. . I never found one that exhibited a greater thickness of coral limestone than 150 feet, or at the very outside 200 feet. . . .

"The third inference is, *that these upraised reef masses in the majority of islands rest on a partially consolidated deposit which possesses the characters of the 'volcanic muds' that were found, during the 'Challenger' Expedition, to be at present forming around volcanic islands.*

"The fourth inference is, *that this deposit envelops anciently submerged volcanic peaks.*"

Mr. Guppy states that his observations have made him a strong adherent of the theory of formation of coral islands advanced by Mr. Murray.

These observations are indeed crucial between the theories of subsidence and of solution, and point towards the newer. The theory of subsidence demands that a coral reef rising from deep water must be of enormous thickness, and rest upon volcanic or fragmental rock; that of solution requires that the reef be of slight thickness and rest on volcanic rock, or consolidated terrigenous mud, or pelagic ooze. According to the former the reef grows on the whole vertically; according to the latter its main extension is horizontal. Two of Darwin's principal objections to the early conception of coral islands were that it was absurd to suppose that submarine mountains were numerous enough to provide foundations for all the known reefs, and that it was impossible to imagine sedimentation taking place at great distances from land. The recent work of telegraph ships along the West Coast of Africa and elsewhere has shown the extreme probability of submarine mountains existing in large numbers throughout the ocean; the cruise of the *Challenger* proved that the shells of pelagic organisms, wind-borne and meteoric dust and volcanic ashes spread by ocean-currents produce perceptible sedimentation in mid-ocean at a rate varying in some inverse proportion to the depth.

Murray's theory can be brought readily to the test of observation and experiment; Darwin's cannot. It has been shown in the laboratory that calcium carbonate is soluble in sea-water, and is dissolved in greater amount in water containing carbonic acid especially when under pressure; the decomposition of dead corals and the respiration of living ones supply carbonic acid to aid in the removal of their calcareous remains. If atolls are formed in areas of elevation, they may ultimately be seen and measured: if only in regions of subsidence, measurement is impossible, and the vertical extent of the coral limestone can only be guessed at.

It must be confessed that the theory of solution in reef-building has not yet been put before the world with any approach to the completeness, lucidity, and grace with which Darwin convinced and enchained the scientific mind. The theory of subsidence is so beautiful, simple, and satisfactory, that very strong evidence is required to shake it; but in the history of science men have more than once been forced to say of a simple and satisfactory doctrine—

"'Twas beautiful,
Yet but a dream, and so—Adieu to it!"

Neither Murray nor Guppy has proved the subsidence theory to be a dream. Still, the solution theory has been plainly set forth, and here we have facts which amount to an absolute proof of its truth for one important group of coral islands. The proof is none the less convincing because it is restricted in its application; for it is concrete and complete in itself, not abstract and cumulative like the evidence for the subsidence theory. Mr. Guppy has demonstrated that the old theory fails and the new succeeds in explaining the formation and structure of the Solomon Islands, and coming at the present time this supplies a powerful argument for the general applicability of the solution theory—an argument that it will not be easy to set aside.

The book is short and interesting; and, besides the important features we have alluded to, it contains much information about the islands visited, and the author's adventures there. HUGH ROBERT MILL.

AGRICULTURE IN SOME OF ITS RELATIONS WITH CHEMISTRY.

Agriculture in some of its Relations with Chemistry. By F. H. Storer. Two Vols. (London: Sampson Low, Marston, Searle, and Rivington, 1887.)

THIS work, by the Professor of Agricultural Chemistry at the Harvard University, is based on a course of lectures delivered annually by the author. It is addressed to students of agriculture and persons fond of rural affairs, rather than to students of chemistry. Free use has been made of German publications in agricultural chemistry, and of the writings of Prof. S. W. Johnson, of Newhaven, Connecticut. Some of the matters treated of in his two well-known books, "How Crops Grow" and "How Crops Feed," have been omitted, or only lightly touched, in the present volumes, which are therefore, to a certain extent, a supplement to those books.

The present volumes treat of the chemistry of the atmosphere, of waters, of soils, and of manures, and of their several relations to plants; the chemistry of animal life and nutrition is not dealt with. A large amount of valuable information, partly of historical interest, has been brought together; and much of it is presented in the somewhat old-fashioned English of the best writers of New England.

One illustration given by the author, to show that liquids penetrate into plants through their roots, we do not think very happy. He notes an observation made by himself, that Indian corn made to sprout in a flower-pot and watered with milk had white leaves; and he suggests that the minute particles of solid matter in the milk must have entered the plant and caused the whiteness. He admits, however, that the whiteness may have been due to chemical action. In noticing the growth of plants in artificial light, he hardly gives sufficient credit to the observations of Siemens and of Dehérain on growth in the light of the electric arc, both uncovered and variously shaded. Mr. Storer has scarcely that respect for earthworms with which Darwin has imbued us, for on the only occasion he mentions them he styles them pernicious, on the ground that harm is done to plants in pots by their casts, which become slimy mud when watered, and thus clog the pores of the earth and the roots of the plants.

In vol. i. p. 295, a serious mistake occurs, though

doubtless by oversight: it is stated that nitrate of soda used as a top-dressing for mowing-fields that contain true grasses "favours the growth of clover rather than of grass." The reverse of this is the truth. There is a good chapter on irrigation, in which it is pointed out that, "in spite of all that has been done of late years in California and the adjacent regions, it is still probably true that no other subject relating to agriculture so much needs to be attended to by the American people as this matter of watering the land." The questions of the disposal of excreta and of sewage are dealt with in their chemical aspects. Perhaps hardly due credit is given to the latest improvements in some precipitation processes for clarifying sewage, but we are glad to see that the author fully realizes that the sewage subject is essentially a sanitary and not an agricultural question. He also exposes some economic fallacies as to the value of sewage by citing various instances in which valuable matters are found at our doors so diluted as not to be worth the cost of collecting or saving. One illustration is the presence of gold in the clay of Philadelphia—1 of gold in about 1¼ million of clay. If the gold from the bricks of the houses could be brought to the surface in the form of gold-leaf, on each brick would be a golden surface of 2 square inches. In the clay beneath the portion of the city already built over is 126 million dollars' worth of gold, yet no one dreams of extracting it. So, except under very favourable conditions for the sewage, valuable manures may be obtained more cheaply than from sewage.

The necessity for the selection of ripe, as well as pure, seeds for sowing, and especially on poor soils, is insisted on and illustrated by records of experiments. The great importance, whether for good or evil, of micro-organisms to the farmer, is often pointed out; and the writer discusses the question of the sources of nitrogen available for plants, and the very important question as to the fixation of free nitrogen from the air by humus or by clay soils. The conclusions of Berthelot, Armsby, Dehérain, and others are stated, and the author regards it as proven, in the light of existing knowledge, that some nitrogen from the air is really fixed as an incident to certain fermentations which occur in the soil. This much debated and debatable point, which is of the utmost economic importance, still requires further elucidation; and we may hope that some further light will be thrown on it by the researches of Sydney Vines on the nutrition of the common bean.

The general nature of the changes brought about in the character of farming by railways and steamships, and the conditions which lead to "high" or to "low" farming, are discussed. An observation of Washington in a letter to Arthur Young is worth recording, in this connexion: "An English farmer must have a very indifferent opinion of our American soil when he hears that an acre of it produces no more than eight to ten bushels of wheat; but he must not forget that in all countries where land is cheap and labour is dear the people prefer cultivating much to cultivating well."

Special chapters are given to barley and oats, and there are three chapters on pastures, grass, and hay, mainly from a New England point of view. In one of these chapters it is stated that the East Anglian word "rowen" for "aftermath," used by old writers, but now, we believe, confined to parts of Suffolk, is in common use in New England.

One minor defect, which might have been remedied by an editor of the English edition, is the use throughout the book of many different systems of weights and measures, *e.g.* the long (English) ton of 2240 pounds, the short (American) ton of 2000 pounds, pounds and bushels per acre as well as kilogrammes per hectare, and German pounds per morgen, per Saxon acre, and per Hessian acre, and even quintals per acre. A reduction of these to one system would have rendered the results more comprehensible, and comparisons easier. Also, a few of the chemical names are not those now in use in this country, and the use of the terms bi-phosphate of lime and di-calcic phosphate as synonymous is very misleading.

For the sake of the British farmer, who is not such a reading man as his American *confrère*, we could wish that some of the subjects had been rather more digested, and that more illustrations had been drawn from English sources, but thanks are due to Mr. Storer for a very suggestive work, that can be confidently recommended to those interested in agriculture for perusal and careful study during the long winter evenings. It cannot fail to awaken a more intelligent interest in the physics and chemistry of the farm. Moreover, notwithstanding the author's modesty, it will be found very useful to the student of agricultural chemistry.

WEATHER.

Weather: a Popular Exposition of the Nature of Weather Changes from Day to Day. By the Hon. Ralph Abercromby. (London: Kegan Paul, Trench, and Co., "International Scientific Series," 1887.)

THE author of this book has undertaken a task the difficulty of which has deterred all previous writers, for FitzRoy's "Weather Book" can hardly be termed a text-book of the subject, and, moreover, it was written at a date at which weather telegraphy was in its infancy. The books which have appeared during the last two decades have been either manuals mainly for the use of seamen, like the Barometer Manuals of the Meteorological Office; or explanations of the interpretation of weather charts, like Mr. Scott's "Weather Charts and Storm Warnings," of which the third edition was lately noticed in these pages. The idea of telling an isolated observer how to employ local weather signs and the manifold modifications of clouds in aiding his own judgment of local weather has not hitherto been adequately carried out.

Mr. Abercromby is peculiarly well qualified for the task of preparing a weather text-book, for not only is he gifted with an unusual faculty of observing weather phenomena, and especially clouds and their changes in this country, as is proved by the papers he has read on various occasions; but he has had more leisure to travel to "foreign parts" than falls to the lot of most meteorologists. The book relates to weather in general, as distinguished from storms, and not merely to the weather of the British Isles; for, though the latter subject occupies most of the work, the information given as to the weather over more extensive areas, such as those of the North Atlantic and the United States, is most instructive and valuable. The

work is divided into two sections, elementary and advanced, of which the former is about one-fourth of the bulk of the latter. The reader must not go away with the idea that the volume contains no original views, for, as Mr. Abercromby says in his preface, "the results of many of the author's original and unpublished researches are included in its pages, such, for instance, as the explanation of many popular prognostics; the elucidation of the general principles of reading the import of cloud-forms; the classification of those cases in which the motion of the barometer fails to foretell correctly the coming weather; and the character of that kind of rainfall which is not indicated in any way by isobaric maps."

Mr. Abercromby's pages convey small consolation to adventurous weather prophets, such as Mr. Wiggins or the framers of the *New York Herald* announcements. At p. 433 we read: "From eight to twelve hours seems to be the furthest time for which forecasts can be issued in advance, and even then many local details cannot be given." Again, at p. 426 he says: "On the whole, we see that the crude notion of forecasting European storms from the United States contains some elements of truth, but that still, from the nature of cyclone motion, the idea can never be used in practical forecasting." His statements as to the impossibility of practically predicting weather by observations of sun-spots are also made with great care.

The most interesting chapters, at least to the ordinary reader, are those which relate to weather prediction, for isolated observers. As regards the formation of clouds and their indications, Mr. Abercromby sets forth the results of much research, but in our opinion he speaks somewhat too decidedly on points which are still *sub judice*.

We welcome the book most cordially, and anticipate a considerable demand for it. We may say, however, that in several places we have noticed slips in the wording, and that the orthography of some of the foreign names is not quite "according to Cocker." In some cases the author's phraseology is not quite clear, and paragraphs have to be read repeatedly before their precise meaning is taken in.

OUR BOOK SHELF.

Class-book of Algebra Examples for Middle and High Schools. Part II., for High Schools. By John Cook, M.A., Principal, Central College, Bangalore. (Madras: printed at the Lawrence Asylum Press, Mount Road. 1887.)

THIS book contains, in addition to the examples which form the main part of the volume, an "Introductory Summary of Rules and Formulæ," extending to about one-third of the whole contents. Although Mr. Cook in his preface lays special stress on this summary, we are by no means sure that its introduction into the volume is an improvement. It is insufficient to allow the student to dispense with the use of a text-book; and a student, who desired to refresh his memory about some particular method or formula, would do better to read it up in his text-book, than to refer to a set of stereotyped rules. Such a summary has the positive disadvantage that it inclines the student to conceive of algebra as consisting entirely of a set of rules, proceeding he knows not whence and leading he knows not whither—a conception which it is one of the chief duties of a teacher of algebra steadily to combat. In parts of this introduction, moreover, there is a looseness of method which is apt to prove very misleading to the student. To refer to only one or two cases in point, we would mention in the first place a confusion between an integral or a rational number and an integral or a rational function. This confusion is shown in the case of division (p. 10) and in the case of root-extraction (pp. 46 and 51). Again, Mr. Cook defines (p. 43) the G.C.M. of two or more fractions, a conception which is perfectly useless in algebra, and only tends to confuse the mind of the learner as to the real meaning of the algebraical G.C.M.

As to the main part of the volume, we are able to compliment Mr. Cook on having brought together a number of examples which are likely to prove useful, especially to teachers. The examples show very considerable variety, those on identities being particularly noteworthy. At the end of each exercise stands a "model solution" which will no doubt prove useful to the student; but what does Mr. Cook mean by saying in one such solution (p. 143) that any three numbers that satisfy the relation $a^2+b^2=c^2$ may be expressed in the form $3n$, $4n$, $5n$? We trust that, should the book reach a second edition, as it doubtless will, Mr. Cook will either dispense with the introduction altogether, which we should be inclined to consider the better plan, or at least remove from it the faults in method to which we have made objection. The good qualities possessed by the main part of the book—the examples themselves—would then render the volume one of undoubted value alike to students and teachers of elementary algebra.

R. E. A.

The Student's Hand-book to the Microscope: a Practical Guide to its Selection and Management. By A Quekett Club Man. (London: Roper and Drowley, 1887.)

ALTHOUGH hand-books and practical guides to the use of the microscope are by no means scarce, this little volume will be welcome to many. It more completely, and in a much smaller compass, meets the precise wants of the beginner who intends to acquire a practical knowledge of the use of the microscope, than the majority of kindred treatises. But it aims only at elementary instruction in the use of the instrument and its accessories. The author does not burden the eager and ambitious amateur who has just become possessed of, or is just about to obtain, a microscope, with the complexities of collecting, preserving, dissecting, preparing, and mounting. There can be no doubt that to obtain a fair initial mastery of a good instrument, with powers up to a quarter-inch objective, and to become facile in the use of all the apparatus which these may involve, for illuminating, polarizing, &c., and, in short, in putting to its best and highest use such a microscope, is by far the better course. To become hastily acquainted with the microscope and its adjuncts, and then to be diverted by elaborate processes for preparing and mounting, is not the surest way to increase the number of skilled and competent masters of the modern microscope. The Quekett Club Man is evidently practical, and sees this. He confines himself to a concise and useful statement, aided by illustrations, of what the microscope is and how its various accessories may be employed.

The author does not claim to take the student into any of the intricacies of high-power work, nor, save in an incidental way, to call attention to the newest microscopy. This is consistent; but we regret that the new and only accurate terminology is not employed. "Numerical aperture," briefly explained, would have been wiser than "angle of aperture," with no comment of any moment as to its relatively unscientific nature. Nor are we quite convinced that, although the author did not hold it to be within his scope to discuss, or even indicate the existence of, "apochromatic lenses," he was as helpful to the uninitiated as he might have been, by not indicating the existence of "compensating eye-pieces"; for both in English and German microscopes, with *any* good objec-

tives, they give better results than the majority of Huyghenian eye-pieces.

We close the book, nevertheless, feeling that it will be an acquisition to many who are without information, and want it, as to how to use the microscope.

A Sketch of Geological History, being the Natural History of the Earth and of its Pre-Human Inhabitants. By Edward Hull, M.A., LL.D., F.R.S. (London: C. W. Deacon and Co., 1887.)

In a prefatory note the publishers of this little book inform the readers that it constitutes the first of a series of volumes devoted to a "Sketch of Universal History." We must congratulate the publishers on having discovered an author with sufficient knowledge, and at the same time with the necessary courage, for coping with such an undertaking. In 148 small pages we have a description of the "original condition of the globe" when it first assumed its present form, followed by sketches of the Archæan and succeeding periods of the earth's history; the whole concluding with a retrospect, which reads like the moral of a fable. The work, it is believed, will form an appropriate introduction to three similar volumes in which the modern history of the world is sketched. The book before us is a marvel of condensation; but in reading it we feel like the unfortunate individuals who are compelled to support life on lozenges composed of "Liebig's Extract."

LETTERS TO THE EDITOR.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.

[The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.

Politics and the Presidency of the Royal Society.

I THINK that you have done the scientific world a great service in pointing out, in language to which it seems to me no one can take exception, the inconveniences which may arise from the President of the Royal Society occupying a seat in Parliament.

No one will, I think, contest the fact that the Royal Society occupies a unique place in our social organization. It differs from all other Societies in constitution, temperament, and tradition. To persons unacquainted with its working, its method of procedure often seems deliberate and formal to a fault. To those who take part in its work it is obvious that its intellectual freedom is absolutely unrestrained, and that, subject to such mistakes as no human institution can claim exemption from, its impartiality and independence of judgment are absolutely unfettered. This arises from the fact that it is a picked body of men of the most diverse mental attitudes, who owe their association to nothing but their own exertions, and who are in the habit of expressing themselves with the utmost frankness on subjects of common interest discussed amongst themselves.

With the general body of Fellows the Council, from the rapidity with which it is changed, is in constant touch. It is no great assumption, then, to conclude that the Council when it speaks will have behind it the approval of the Fellows—that is, in point of fact, the sanction of the general scientific opinion of the Empire.

Now, the President of the Royal Society, when he speaks officially, is something more than the President of a learned Society: he is virtually the Speaker of the English scientific world. This being so, his position appears to me to be no small one. It is one which in emergencies may become of paramount importance. And it is this view of his position which disposes me to think that it is desirable that the occupant of such a post should be politically unfettered. I apprehend that this view is shared by Prof. Balfour Stewart when he says: "I grant freely that under ordinary circumstances it is undesirable that the President of the Royal Society should enter the House of Commons." And it is not difficult to see why it is undesirable.

Successive Governments, as is well known, are in the habit of consulting the Royal Society on scientific questions, the solution of which may possibly influence or determine a public policy. To such appeals the Royal Society has hitherto replied to the best of its ability without fear or favour. Will it always have the same freedom when its President is amenable to party discipline? It is only necessary to point to the last session of Parliament to see that there were many occasions when the position of the President on the Government benches would have been a not wholly pleasant one. Much bebadgered Ministers would perhaps have come up to him and have said, You must really make some concession, and the man would be made of iron who would not sometimes yield. Then, having been squeezed himself, he would return to his Council with:—"In the House of Commons the other night a very strong opinion was expressed to me," &c., and the process of squeezing would be transferred to the Council. It is no use saying that these things would not happen; because everyone knows that in actual political life they do. If the President descends from the dignified reserve which hedges him in at Burlington House, he will have to take his chance with the disabilities of the ordinary Parliamentary rank and file.

I cannot therefore resist the conclusion that a President of the Royal Society owes it to himself and to his position to hold aloof from all influences that would impair his freedom, and, as a consequence, that of the Society. His position is one of the few in the country which is unique not merely from its absolute independence of external public influence, but from the sanction which is given to the action of its occupant by internal support. The impossibility of allowing the Judges to sit in the House of Commons is, I suppose, apparent to everyone, and, in my view, every disability in that respect which attaches to them attaches with equal force to the President.

I will only trespass on your space with two further observations.

Prof. Balfour Stewart's last argument is, of course, purely political, and, being so, appears to me to be the one thing needed to demonstrate the unadvisability of any exception to the general principle to which he adheres. He says that the President "has chosen to be an Englishman first and a man of science afterwards." Yes. But—and I trust that no shade of impropriety may be thought to attach to the argument—would he have been as equally acquiescent had the President chosen the political *rôle* of Irishman as his first duty?

Lastly, Prof. Williamson remarks that our President cannot "be supposed to have entered the House as the political representative of the Royal Society." But unfortunately he cannot help himself. He cannot sink his official status. The House of Commons will take note of it just as it does of that of the Lord Mayor and of the Chairman of the Metropolitan Board of Works, who do not sit in Parliament by virtue of their official positions. Yet, being there, they are liable to interpellations with respect to the business of the bodies over which they preside. I do not see why the President of the Royal Society should expect immunity from the same discipline, and the result, it is easy to see, might be extremely embarrassing to the Royal Society, which has other, and in my opinion more constitutional, modes of communicating with the Government, and, if need be, with Parliament.

I say these things not because I like saying them, but because, feeling as I do, I do not think I ought to abstain from saying them. No one has a higher admiration for our President than I have, and no one would less willingly utter a syllable that would give him pain. I rejoice in one aspect of the case, that the University of Cambridge has crowned a great scientific career by a signal honour. But I cannot but feel that the authority and position of the Presidency of the Royal Society belong to a sphere of action infinitely above the conflict of parties, and that they will run a serious risk of impairment when the honoured name of its occupant appears for the first time in modern scientific history in the lists of a party division.

W. T. THISELTON DYER.

Royal Gardens, Kew, November 26, 1887.

As a Fellow of the Royal Society who has sat for many years continuously in the House of Commons, I have read with much interest your article on the above subject, which, from a Royal Society point of view (but not in any sense from a Parliamentary stand-point) is one of very great importance. No reasonable person would for a moment object, I presume, to Prof. Stokes entering Parliament as a politician, if he be one, provided he be very careful to doff at the door of the House of Parliament every vestige of Royal Society representation, and appear there as a private politician to be taken for just what he is worth in that capacity, and no more. Do not let me be misunderstood : as a man of science he will, even in the House of Commons, receive the personal consideration due to his distinguished personal attainments ; and few public assemblies are more ready than that House to give the full value to personal qualities and achievements. But the President of the Royal Society will put that distinguished body, no less than himself, in a thoroughly false position if he presumes to utter there a single sentence in its name. Should I be present—and the same may be said, I trust, of other Fellows—I shall not hesitate to rise instantly and disclaim his pretensions, and declare that he has no more authority than one of the doorkeepers to speak in a political assembly in the name of the Society over which in a purely scientific capacity he presides.

Having a most careful regard to the purity of your columns in respect of everything merely political, I find it very difficult to say much of what I think and feel on this question ; but when I consider the depths to which a certain ex-Professor has descended since he seated himself upon the steep and slippery slope of politics, I must very earnestly deprecate any similar proceeding on the part of the highest officer of the Royal Society, in that capacity. In the political arena, I fear, we are on both sides daily getting a lower and lower opinion of our opponents, and I must confess that it is rapidly becoming hard to reconcile with the scientific spirit the rancorous abuse and unreasoning misrepresentation with which we are now too familiar.

But I must not be drawn into either polemics or personality. I must content myself with saying, that, if Conservatives think meanly of Liberal politicians just now, their sentiment is thoroughly reciprocated, and probably more than reciprocated, by those who, like myself, believe we have at heart the true greatness, the lasting tranquillity and the intellectual and social progress of the country. For Heaven's sake let us keep the Royal Society, if not above, at least most distinctly apart from, all political contentions ; and, in order that we may do this, let its President, who has now become a professed party politician, either vacate the chair, or make it absolutely clear that on the floor of Parliament he will not presume to speak with any kind or degree of authority in the name of the Society.

I have no idea, Sir, of your political views, but I appreciate your desire to keep the Royal Society politically neutral—aye, politically non-existent—and I hope your timely and courageous warning will not have been given in vain.

I have no care to conceal my name, but the end in view may be best promoted, perhaps, by my merely signing myself,

F.R.S. AND M.P.

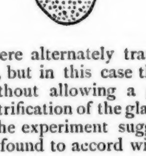
Library of House of Commons, November 21.

The Vitreous State of Water.

TO-DAY, between 2 and 3 p.m., with the barometer standing at 29 inches, the thermometer a little below 0° C., and the wind north-east, we had for the space of about twenty minutes an interesting fall of hail in this neighbourhood. The stones varied in size from that of a mustard-seed to that of a hemp-seed or thereabouts. Some rain accompanied them, and this became frozen in part on cold exposed surfaces. The stone sill of my study window, which faces nearly north-west, was soon covered in this way with a thin pellicle of ice, which served as a convenient resting-place for the hailstones at a low temperature. I was struck at once with their glassy appearance, and examined a number of them with a pocket lens as they lay on the cold surface of the stone, not having at hand any refrigerating arrangement adjustable to the stage of a microscope. Nor was the latter necessary. The lens showed most distinctly the clear transparency of the glass of which these hailstones consisted, and the vitreous fracture of some which had been broken by impact. Watching them as they lay, one saw minute nests of crystals form, in some cases in a peripheral zone, extending gradually inwards ; but in the majority of instances the crystallization began in the centre of the ice, and gradually extended in a beautiful crystal growth more or less through the mass.

There would seem to be no room left for doubt that this crystal-building process (sometimes in bands, sometimes in confused nests of crystals) was a simple case of devitrification—as distinct a case, one may almost say, as the well-known devitrification on a larger scale which is clearly exhibited by some glassy slags. The fact of lying on a surface below 0° C., and undergoing devitrification instead of liquefaction, seems to lend direct support to the theory of *latent heat of the vitreous state*, which I have ventured elsewhere to propound (see NATURE, vol. xxxvi. p. 77).

I may add that last July, in a much heavier hailstorm in the Trent Valley, I noticed a very great number of hailstones, many of them as large as a moderate-sized hazel-nut, and peg-top shaped, with a zonal or banded structure thus :—



The layers or zones were alternately transparent and opaque (apparently crystalline), but in this case the temperature caused them to melt away without allowing a good opportunity for observation of any devitrification of the glassy portions. To-day Nature has performed the experiment suggested in my previous letter, and the result is found to accord with the theory.

A. IRVING.

Wellington College, Berks, November 18.

The Bagshot Beds.

IT may interest some of your readers to know that I recently obtained some casts of fossils from the Bagshot Sands of the Newbury district, from which, with one doubtful exception ("Survey Memoir," vol. iv. p. 330), they have not, I believe, hitherto been recorded. The fossils are of the nature of ferruginous casts, and were found in a sand-pit about one-third of a mile south-east of the London lodge of Highclere Park, mapped by the Survey as Lower Bagshot. They consist both of univalves and bivalves, and four or five genera are represented. They resemble, both in appearance and mode of occurrence, the fossils found in the Upper Bagshot of the Bagshot district ; and the sands in which they occur have a strong resemblance to the

sands of that division. To whatever division, however, of the Bagshots these beds may be assigned eventually, the occurrence of fossils in them is, I think, worthy of record.

53 Warwick Square, November 25. R. S. HERRIES.

The Ffynnon Beuno and Cae Gwyn Caves.

SINCE writing my note, as published in NATURE of November 3, p. 7, I have paid another visit to the British Museum, and seen a second implement from the Denbighshire caves, presented by Dr. Hicks and Mr. Luxmore. It is a small and highly-finished scraper, exactly agreeing with the Neolithic scrapers of Icklingham and Mildenhall, and with small scrapers found in caves of confessedly very late date. This scraper is quite sufficient to condemn any pre-Glacial theory, and it enables me to emphasize my former remark that the cave contents, instead of belonging to the earliest Palæolithic class, belong to the *very latest*. I do not believe that a similar scraper has ever been found in any *really old, or even moderately old, Palæolithic river gravel*. Such scrapers were only made in the most recent of Palæolithic times.

Mr. G. H. Morton is not justified in his remark (Nov. 10, p. 32) that my former letter afforded "a remarkable instance of rushing into print and giving an opinion on a subject with which the writer was unacquainted," for I have studied the drifts of Wales for twenty years, and during that time I have never failed to make one or two visits a year to Wales. I have also examined nearly every cave in North and South Wales, and handled the shovel and pickaxe myself. From the experience I have obtained during this time, I say the drift in front of the Denbighshire caves is *not in its original position*, but *distinctly and obviously relaid;* and I even doubt whether before it was relaid it was a true Glacial gravel at all.

I will "read up the literature of the subject" if I get time: in the meantime there is no great harm done in expressing an opinion from a study of some of the real objects, even if that opinion is "not worth anything" and "of no consequence," as Mr. Morton concludes. WORTHINGTON G. SMITH.

Meteor.

ON Tuesday night, November 15, a wonderfully fine meteor was seen at Falmouth, and being out star-gazing at the time, I was fortunate enough to see it. I was looking towards that part of the Milky Way between Auriga, Perseus, and Cassiopeia, when suddenly a curved train of light flashed out; but, instead of just going away, it remained visible for quite eight seconds; meanwhile the lower extremity burst into a brilliant mauve "cone" of light, about a quarter the size of the full moon. So bright was it that it lit up the roadway, quite overpowering the lamps.

It was a grand sight, and I sincerely hope other eyes than mine saw it. B. TRUSCOTT.

4 Alma Crescent, Falmouth.

MODERN VIEWS OF ELECTRICITY.[1]

PART III.—MAGNETISM.

V.

WE next proceed to consider electricity in a state of *rotation*. What happens if we make a whirlpool of electricity? Coil up a wire conveying a current, and try. The result is it behaves like a magnet: compass-needles near it are affected, steel put near it gets magnetized, and iron nails or filings get attracted by it—sucked up into it if the current be strong enough. In short, it *is* a magnet. Not of course a permanent one, but a temporary one, lasting as long as the current flows. It is thus suggested that magnetism may perhaps be simply electricity in rotation. Let us work out this idea more fully.

First of all, one may notice that everything that can be done with a permanent magnet can be imitated by a coiled wire conveying a current. (It would not do altogether to make the converse statement.) Float a coil attached to a battery vertically on water, and you have a compass-needle: it sets itself with its axis north and south. Suspend two coils, and they will attract or repel or turn each other round just like two magnets.

As long as one only considers the action of a coil at some distance from itself, there is no need to trouble about the shape of the particular magnet which it most closely simulates; but as soon as one begins to consider the action of a coil on things close to it, it is necessary to specify the shape of the corresponding magnet.

If the coil be a long cylindrical helix like a close-spired corkscrew, as in Fig. 16, it behaves like a cylindrical magnet filling the same space. But if the coil be a short wide hank, like a curtain-ring, it behaves again like a cylindrical magnet, but one so short that it is more easily thought of as a disk. A disk or plate of steel magnetized with one face all north and the other face all south can be cut to imitate any thin hank of wire conveying a current. It will be round if the coil be round, square if it be square, and irregular in outline if the coil be irregular.

There is no need for the coil to have a great number of turns of wire except to increase its power: one is sufficient, and it may be of any shape or size. So when we come to remember that every current of electricity must necessarily flow in a closed circuit, one perceives that *every current of electricity is virtually a coil of more or less fantastic shape*, and accordingly imitates some magnet or other which can be specified. Thus we learn that every current of electricity must exhibit magnetic phenomena: the two are inseparable—a very important truth.

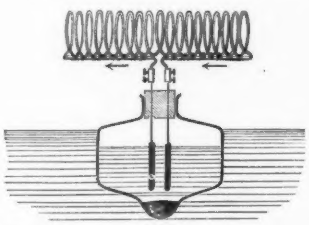


FIG. 16.—Floating battery and helix acting as a compass-needle.

There is one detail in which the magnetized disk and the coil are not equivalent, and the advantage lies on the side of the coil: it has a property beyond that possessed by any ordinary magnet. It has a penetrable interior, which the magnet has not. For space outside both, they simulate each other exactly; for space inside either, they behave differently. The coil can be made to do all that the magnet can do; but the magnet cannot in every respect imitate and replace the coil: else would perpetual motion be an every-day occurrence.

Now I want to illustrate and bring home forcibly the fact that there is something rotatory about magnetism—something in its nature which makes rotation an easy and natural effect to obtain if one goes about it properly. One will not observe this by taking two magnets: one will see it better by taking a current and a magnet, and studying their mutual action.

A magnet involves, as you know, two poles—a north and a south pole—of precisely opposite properties: it may be considered as composed of these two poles for many purposes; and the action of a current on a magnet may be discussed as compounded of its action on each pole separately. Now how does a current act on a magnetic pole? Two currents attract or repel each other; two poles attract or repel each other; but a current and a pole exert a mutual force which is neither attraction nor repulsion: it is a rotatory force. They tend neither to approach nor to recede; they tend to revolve

[1] This Part is an expansion of a lecture delivered at the London Institution on January 5, 1885. Continued from p. 13.

round each other. A singular action this, and at first sight unique. All ordinary actions and reactions between two bodies take place in the line joining them: the forces acting between a current and a pole act exactly at right angles to the line joining them.

Helmholtz long ago (in 1847) showed that the conservation of energy could only be true if forces between bodies varied in some way with distance and acted in the line joining them. Now here is a case where the forces are not in the line joining the bodies, and accordingly the conservation of energy is defied: the two things will revolve round each other for ever. This affords and has afforded a fine field for the perpetual motionist; and if only the current would maintain itself without sustaining power, a perpetual motion would in fact be attained. But this after all is scarcely remarkable, for the same may be said of a sewing-machine or any other piece of mechanism: if only it would continue to go without sustaining power it would be a perpetual motion. Attend to pole and current only, and the energy is *not* conserved, it is perpetually being wasted; but include the battery as an essential part of the complete system, and the mystery disappears: everything is perfectly regular.

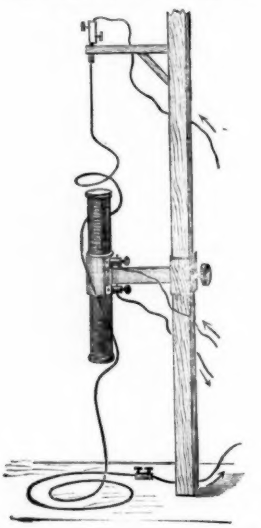


FIG. 17.—A long flexible conductor twisting itself into a spiral round a powerful bar-magnet.

The easiest way perhaps of showing the rotation of a conductor conveying a current round a magnetic pole is to take an 8-feet-long piece of gold thread, such as military officers stitch upon their garments, and hanging it vertically supply it with as strong a current as it will stand. Then bring near it a vertical bar-magnet, and instantly you will see the thread coil itself into a spiral, half of it twisting round the north end of the bar, and half twisting the other way round the south end (Fig. 17).

If the magnet were flexible and the conductor rigid, the magnet would in like manner coil itself in a spiral round the current: the force is strictly mutual. A rigid magnet put near a stiff conductor shows only the last remnants of this action: it sets itself at right angles to the wire, and approaches its middle to touch it, but that is all it can do.

The experiment with the flexible gold thread is simple, satisfactory, and striking, but the rotatory properties connected with a magnet may be illustrated in numbers of other ways. Thus, pivot a disk at its centre, and arrange some light contact to touch its edge, either at one point or all round, it matters not; then supply a current to disk from centre to circumference, and bringing a bar-magnet near it along its axis, or, better, two bar-magnets, with

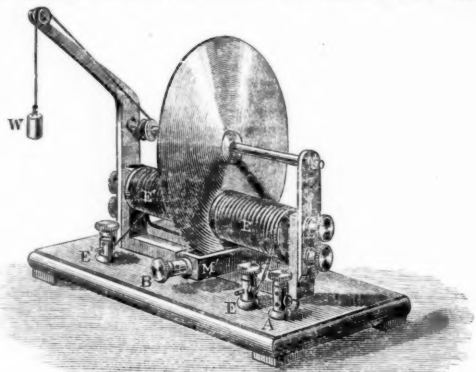


FIG. 18.—Pivoted disk with radial current, revolving in a magnetic field and winding up a weight. The current is supplied to the axle by screw A, and leaves the rim by mercury trough M. The same apparatus obviously serves to demonstrate currents induced by motion; both directly and by the damping effect.

opposite poles one on each side, near the contact place of the rim, the disk at once begins to rotate (Figs. 18 and 19).

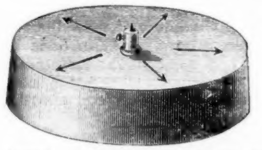


FIG. 19.—Another pivoted disk with flange to dip into liquid so as to make contact all round its rim. It rotates when a magnet is brought above or below; or even in the field of the earth.

Instead of a disk one may use a single radius of it, viz. a pivoted arm (Fig. 20) dipping into a circular trough of mercury; or we may use a light sphere rolling on two

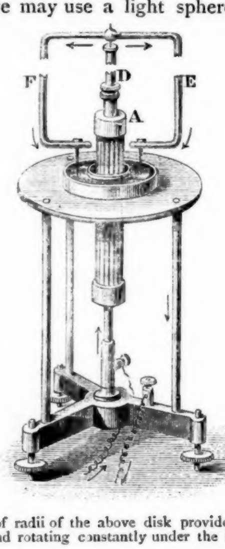


FIG. 20.—A couple of radii of the above disk provided with points to dip into mercury, and rotating constantly under the influence of the steel magnet A.

concentric circular lines of railway (Gore's arrangement, Fig. 21). In every case rotation begins as soon as a magnet is brought near.

Nor is the revolving action confined to metallic conductors and to true conduction. Liquids and gases, although they convey electricity by something of the

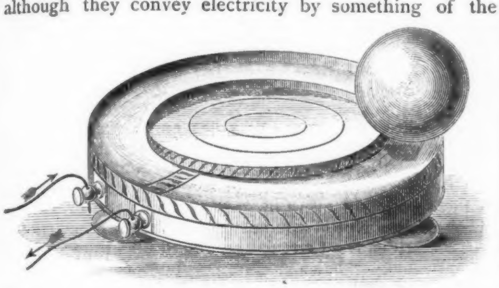


FIG. 21.—Gore's circular railway. The light spherical metal ball revolves round the two concentric metal hoops or rails whenever it is made to convey a current between them in a vertical magnetic field.

nature of convection, are susceptible to rotation in a precisely similar manner.

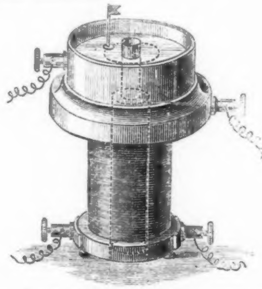


FIG. 22.—Rotation of a liquid disk conveying a radial current in a vertical magnetic field.

To show the rotation of liquid conductors under the influence of a magnet, take a circular shallow trough of

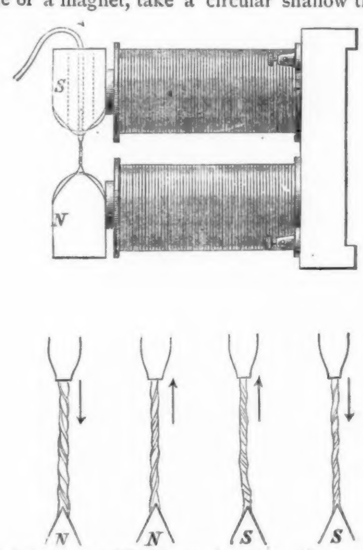


FIG. 23.—A falling stream of liquid conveying a current between two magnetic poles, and being thereby twisted into a spiral. (Copied from a paper in Phil. Mag. by Dr. Silvanus Thompson).

liquid, supply it with electrodes at centre and circumference, and put the pole of a magnet below it. The liquid at once begins to rotate, and by using a magnet and current of fair strength can easily be made to whirl so fast as to fly over the edge of the trough (Fig. 22). The experiment is plainly the same as Fig. 19, except that a liquid disk is used in place of a solid one. Or, again, it may be considered the same as Fig. 20. Reverse the magnet, and the rotation is rapidly reversed.

Another method is to send a current along a jet of mercury near a magnet and note the behaviour of the jet. It twists itself into a flat spiral as shown in Fig. 23.

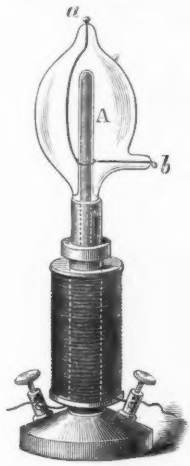


FIG. 24.—Induction coil discharge from *a* to *b* through rarefied gas, rotating round a glass-protected magnetized iron rod.

The rotation of a gas discharge is most commonly illustrated by an arrangement like Fig. 24, where the terminals of the induction coil are connected to the rarefied gas respectively above one pole and round the middle of a magnetized bar. If the discharge can be got to concentrate itself principally down one side, the line of light so formed is seen to revolve.

Action between a Magnet and an Electric Charge in Relative Motion.

From all this it is not to be doubted that a charged pith ball moving in the neighbourhood of a magnet is subject to the same action. There is no known action between a magnet and a *stationary* charged body, but directly either begins to move there is an action between them tending to cause one to rotate round the other. It is true that for ordinary speeds of motion this force is extremely small; but still it is not to be doubted that if a shower of charged pith balls or Lycopodium granules are dropped on to a magnet pole, they will fall, not perfectly straight, but slightly corkscrew fashion. And again, if a set of charged particles were projected horizontally and radially from the top of a magnet, their paths would revolve like the beams of a lighthouse. And if by any means their paths were kept straight, or deflected the other way, they would exert on the magnet an infinitesimal "couple" tending to make it spin on its own axis.

Conversely, if a magnet were spun on its axis rapidly by mechanical means, there is very little doubt but that it would act on charged bodies in its neighbourhood, tending to make them move radially either to or from it. This, however, is an experiment that ought to be tried; and the easiest way of trying it would be to suspend a sort of electrometer needle, electrified positive at one end and negative at the other, near the spinning magnet, and to look for a trace of deflection—to be reversed when the spin is reversed. A magnet of varying strength might be easier to try than a spinning one.

Rotation of a Magnet by a Current.

The easiest way to show the actual rotation of a magnet is to send a current half way along it and back

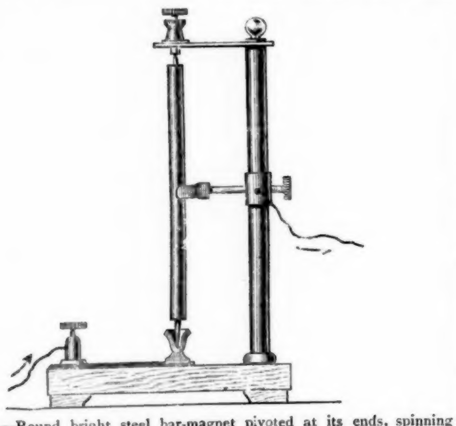


FIG. 25.—Round bright steel bar-magnet pivoted at its ends, spinning rapidly on its axis under the influence of a current supplied to either the bottom or top pivot, or both, and removed near the middle by a scrap of tinfoil lightly touching it.

outside. Thus, take a small, round, polished steel bar-magnet with pointed ends, pivot it vertically, and touch it steadily with two flakes or light pads of tin-foil, one

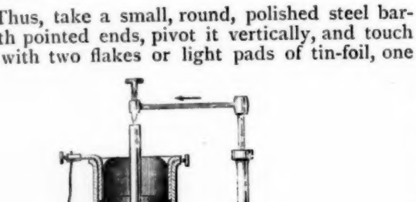


FIG. 26.—Another mode of exhibiting the same thing as Fig. 25. The magnet is loaded so as to float upright in mercury.

near either end and one near the middle; supply a current by these contact pieces, and the magnet spins with great rapidity. Reverse the current, and it rotates

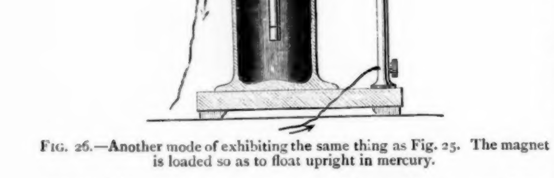


FIG. 27.—The converse of Fig. 25. Spinning the magnet mechanically give a current between two springs, one touching it near or beyond eithe end, the other touching it near middle.

the other way. Conversely, by producing the rotation mechanically a current will be excited in a wire joining the two pieces of tin-foil (Figs. 25, 26, and 27).

Many more variations of the experiment could be shown, but these are typical ones, and will suffice. They all call attention to the fact that a magnet, considered electrically, is a rotatory phenomenon.

Ampère's Theory.

The idea that magnetism was nothing more nor less than a whirl of electricity is no new one—it is as old as Ampère. Perceiving that a magnet could be imitated by an electric whirl, he made the hypothesis that an electric whirl existed in every magnet and was the cause of its properties. Not of course that a steel magnet contains an electric current circulating round and round it, as an electro-magnet has: nothing is more certain than the fact that a magnet is not magnetized as a whole, but that each particle of it is magnetized, and that the actual magnet is merely an assemblage of polarized particles. The old and familiar experiment of breaking a magnet into pieces proves this. Each particle or molecule of the bar must have its circulating electric current, and then the properties of the whole are explained.

There is only one little difficulty which suggests itself in Ampère's theory—How are these molecular currents maintained? Long ago a similar difficulty was felt in astronomy—What maintains the motions of the planets? Spirits, vortices, and other contrivances were invented to keep them going.

But in the light of Galileo's mechanics the difficulty vanishes. Things continue in motion of themselves until they are stopped. Postulate no resistance, and motion is essentially perpetual.

What stops an ordinary current? Resistance. Start a current in a curtain ring, by any means, and leave it alone. It will run its energy down into heat in the space of half a second or so. But if the metal conducted infinitely well there would be no such dissipation of energy, and the current would be permanent.

In a metal rod, electricity has to pass from atom to atom, and it meets with resistance in so doing; but who is to say that the atoms themselves do not conduct perfectly? They are known to have various infinite properties already: they are infinitely elastic, for instance. Pack up a box of gas in cotton-wool for a century, and see whether it has got any cooler. The experiment, if practicable, should be tried; but our present experience warrants us in assuming no loss of motion among the colliding atoms until the contrary has been definitely proved by experiment. To all intents and purposes *certainly* atoms are infinitely elastic: why should they not also be infinitely conducting? Why should dissipation of energy occur in respect of an electric current circulating wholly inside an atom? There is no known reason why it should. There are many analogies against it.

How did these currents originate? We may as well ask, How did any of their properties originate? How did their motion originate? These questions are unanswerable. Suffice it for us, there they are. The atoms of a particular substance—iron for instance, or zinc—have an electric whirl of certain strength circulating in them as one of their specific physical properties.

This much is certain, that the Ampèrian currents are not producible by magnetic experiments. When a piece of steel or iron is magnetized, the act of magnetization is not an excitation of Ampèrian current in each molecule—is not in any sense a magnetization of each molecule. The molecules were all fully magnetized to begin with: the act of magnetization consists merely in facing them round so as to look mainly one way—in polarizing them, in fact. This was proved by Beetz long ago; I will not stop to explain it further, but will refer students to Maxwell.

Ampère's Theory extended by Weber to explain Diamagnetism also.

Let us see how far we have got. We have made the following assertions :—

(1) That a magnet consists of an assemblage of polarized molecules.

(2) That these molecules are each of them permanent magnets, whether the substance be in its ordinary or in its magnetized condition, and that the act of magnetization consists in turning them round so as to face more or less one way.

(3) That when all the molecules are faced in the same direction the substance is magnetically completely saturated.

(4) That if each molecule of a definite substance contains an electric current of definite strength circulating in a channel of infinite conductivity the magnetic behaviour of the substance is completely explained.

But now, supposing all this granted, how comes it that the molecular currents are not capable of being generated by magnetic induction? And if we cannot excite them, are we able to vary their strength?

The answer to these questions is included in the following propositions, which I will now for convenience state, and then proceed to explain and justify.

(5) If a substance possessing these molecular currents be immersed in a magnetic field, all those molecules which are able to turn and look along the lines of force in the right direction will have their currents weakened; but on withdrawal from the field they will regain their normal strength.

(6) If the currents flowing in the conducting channels be feeble or *nil*, the act of immersion of the substance in a magnetic field will reverse them or excite *opposite* currents, which will last so long as the body remains in the field, but will be destroyed by its removal.

(7) The molecular currents so magnetically induced are sufficient to explain the phenomena of *diamagnetism*.

Let us first just recall to mind the well-known elementary facts of current induction. A conducting circuit, such as a ring or a coil of wire, suddenly brought near a current-conveying coil or a magnet, has a momentary current induced in it in the opposite direction to the inducing current—in other words, such as to cause momentary repulsion between the two. So long as it remains steady, nothing further happens; but on withdrawing it another momentary current is induced in it in the contrary direction to that first excited. The shortest way of expressing the facts quite generally is to say that while from any cause the magnetic field through a conductor is increasing in strength a current is excited in it tending to drive it out of the field: the disturbance is only temporary, but whenever the magnetic field decreases again to its old value a reverse flow of precisely the same quantity of electricity occurs. Fig. 28 shows a mode of illustrating the facts. A copper disk is supported at the end of a torsion arm and brought close to the face of an unexcited bar electro-magnet. On exciting the magnet the disk is driven violently away: to be sucked back again, however, whenever the magnetism ceases.

Now, why are all these effects so momentary? What makes the induced current cease so soon after excitation? Nothing but dissipation of energy: only the friction of imperfect conductivity. There is nothing to maintain the current: it meets with resistance in its flow through the metal, and so it soon stops.

But in a perfect conductor like a molecule no such dissipation would occur. Electricity in such a body will obey the first law of motion, and continue to flow till stopped. Destroying the magnetic field will stop an induced molecular current, but nothing else will stop it. Hence it follows that the repulsion experienced is no transitory effect like that in Fig. 28, but is as permanent as the magnetic field which excites and exhibits it.

Thus, then, a body whose molecules are perfectly conducting, but without specific current circulating in them, will behave diamagnetically, *i.e.* will move away from strong parts of the field towards weak ones, and thereby set its length equatorially, just as bismuth is known to do.

Whether this be the true explanation of diamagnetism or not, it is at least a possible one. It is known as Weber's theory.

It does not necessarily follow that the specific molecular currents of a diamagnetic substance are really *nil*; all that is needful is that they shall be weaker than those induced by an ordinary magnetic field. By using an extremely weak field, however, the specific currents need not be quite neutralized, and in such a field the body ought to behave as a very feebly magnetic substance. Such an effect has been looked for (see NATURE, vol. xxxv. p. 484).

One loop-hole there is, however, viz. that every molecule may be so jammed as to be unable to turn round, and such a substance could hardly exhibit any noticeable magnetic properties. The molecules would have got themselves into a state of minimum potential energy, and if jammed therein nothing could be got out of them. The induced currents of diamagnetism would be superposed

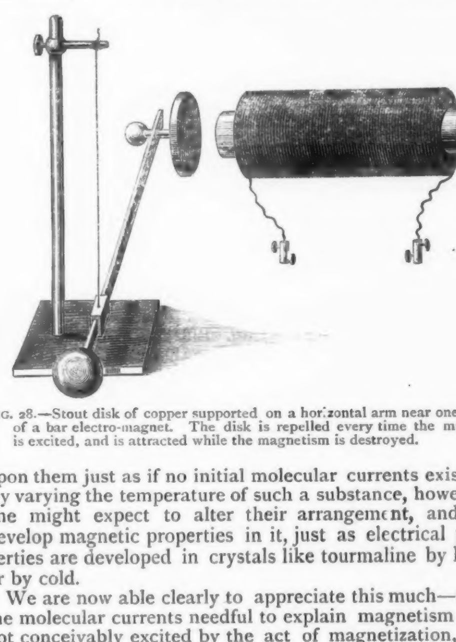


FIG. 28.—Stout disk of copper supported on a horizontal arm near one pole of a bar electro-magnet. The disk is repelled every time the magnet is excited, and is attracted while the magnetism is destroyed.

upon them just as if no initial molecular currents existed. By varying the temperature of such a substance, however, one might expect to alter their arrangement, and so develop magnetic properties in it, just as electrical properties are developed in crystals like tourmaline by heat or by cold.

We are now able clearly to appreciate this much—that the molecular currents needful to explain magnetism are not conceivably excited by the act of magnetization, for they are in the wrong direction. *Induced* molecular currents will be such as to cause repulsion: those which cause attraction must have existed there before, and be merely rotated into fresh positions by the magnetizing force.

Function of the Iron in a Magnet. Two Modes of expressing it.

We can now explain the function of iron, or other magnetic substance, in strengthening a magnetic field. Take a circular coil of wire, Fig. 29, and send a current round it: there is a certain field—a certain number of lines of force—between its faces. Fill the coil with iron, so as to make it a common electro-magnet, and the strength of the field is greatly increased. Why? The common mode of statement likens the magnetic circuit to a voltaic circuit; there is a certain magneto-motive

force, and a certain resistance: the quotient gives the resulting magnetic induction, or total number of lines of force. Iron is more permeable than air—say, 300 times more permeable—and accordingly the resistance of the iron part of the circuit is almost negligible in comparison with that of the air-gap between the poles. Thus a good approximation to the total intensity of field is obtained by dividing the magneto-motive force by the width of the air-gap; or more completely and generally by treating the varying material and section of a magnetic circuit just as the varying material and section of a voltaic circuit is treated, and so obtaining its total resistance. Iron is thus to be regarded as a magnetic conductor some 300 times better than air.

This mode of regarding the case is undoubtedly simple and convenient, but it is not the fundamental mode. If we look at it less with a view to practical simplicity than with the aim of seeing what is really going on, we shall express it thus:—

Before the iron was inserted in the coil there were a certain number of circular lines of force inside it due to the current alone. A piece of common iron, although

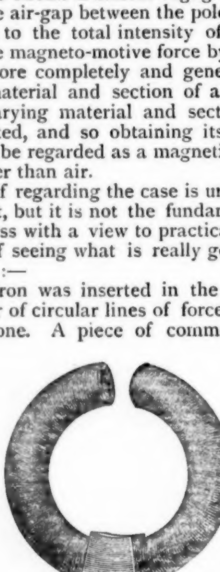


FIG. 29.

full of polarized molecules, has no external or serviceable lines of force: they are all shut up, as it were, into little closed circuits inside the iron. But directly the iron finds itself in a magnetic field some of these open out, a chain of polarized molecules is formed, and the lines due to its molecular currents add themselves to those belonging to the current of the magnetizing helix.

Thus our ring electro-magnet has now not only its own old lines of force, but a great many of those belonging to the iron which have sympathetically laid themselves alongside the first.

The end result of either mode of regarding the matter is of course the same—the lines of force between the poles are increased in number by the presence of iron; but whereas, in the first-mentioned mode of treatment, the fact of permeability had to be accepted unexplained, in the second nothing is unexplained except the fundamental facts of the subject, such as the reason why currents tend to set themselves with their axes parallel, and other matters of that sort.

Electrical Momentum once more.

There is just one point which I must stop here to call attention to. The theories of magnetism and diamagnetism, which I have given according to Ampère, Weber, and Maxwell, require as their foundation that in a perfect conductor electricity shall obey the first law of motion—shall continue to flow until stopped by force. But the property of matter which enables it to do this is called *inertia;* the law is called the law of inertia; and anything which behaves in this way must be granted to possess inertia.

It would not do to deduce so important a fact from a yet unverified theory; but at least one must notice that it is essentially involved in Ampère's theory of magnetism. It is the only theory of magnetism yet formulated, and it breaks down unless electricity possesses inertia.

Nevertheless it is a fact that an electro-magnet does not behave in the least like a fly-wheel or spinning-top: there is no momentum mechanically discoverable. Supposing this should turn out to be strictly and finally true, we must admit that a molecular electric current consists of two equal opposite streams of the two kinds of electricity: one must begin to regard negative electricity not as merely the negation or defect of positive, but as a separate entity. Its relation to positive may turn out to be something more like that of sodium to chlorine than that of cold to heat.

I said that no effect due to electric inertia was *mechanically* discoverable, but that is perhaps too sweeping a statement. Think of a couple of india-rubber pipes tied together so as to form a double tube, and through each propel a current of water, one in an opposite direction to the other. Although the double current has no gyrostatic properties, yet the water exhibits momentum, even when the current is quite steady, by its effect on kinks and bends and curves in the tube: these all tend to straighten or smooth themselves out, and the tube if quite free would become a perfect circle.

Precisely the same effect can be observed with a flexible conducting wire or gold thread. Throw a loop of very light flexible thinly-covered stranded wire at random on a glass slab, and pass a strong current through it: it will tend to round off its sharp corners, open out its tangled loops, and do its best to become a perfect circle; and this quite independently of the earth's field, in accordance with the principle numbered 3 on page 8. It will be at once objected that this effect, in the case of the wire, is due to something going on in the medium surrounded by it, and not simply to the inertia of anything in the conducting channel itself, as in the water case. The objection is, of course, perfectly valid, but nevertheless the effect is one worth bearing in mind; and its ultimate explanation may lead us to postulate inertia quite as essentially though not so superficially as the crude hydraulic analogy suggests.

So long as one considered the flow of electricity in ordinary conductors, we could partially avoid the question of inertia by considering it urged forward at every point with a force sufficient to overcome the resistance there and no more; but though this explained the shape of the stream-lines (Fig. 15) yet it did not suffice to render clear the phenomena of self-induction—the lag of the interior electricity in a wire behind the outside until definitely pushed; and still more its temporary persistence in motion after the pushing force has ceased.

But, now that we are dealing with perfect conductors with no pushing force at all, the persistence of molecular currents without inertia, or an equivalent property so like it as to be rightly called by the same name at present, becomes inexplicable. True, the molecular currents are as yet an hypothesis; and that is the only loop-hole out of a definite conclusion.

OLIVER J. LODGE.

(*To be continued.*)

DISCOVERY OF DIAMONDS IN A METEORIC STONE.

In a Russian paper of October 22 last appears a preliminary report of the examination by Latschinof and Jerofeief, Professors of Mineralogy and Chemistry respectively, of a meteoric stone weighing 4 lbs., which fell in the district of Krasnoslobodsk, Government of Pensa, Russia, on September 4, 1886.

In the insoluble residue small corpuscles showing traces of polarization were observed; they are harder than corundum, and have the density and other characters

of the diamond. The corpuscles are said to amount to 1 per cent. of the meteoric stone.

Carbon, in its amorphous graphitic form, has been long known as a constituent of meteoric irons and stones; lately, small but well-defined crystals of graphitic carbon having forms often presented by the diamond, were described in our columns as having been found in a meteoric iron from Western Australia. If this supplementary discovery be confirmed, we may at last be placed on the track of the artificial production of the precious stone.

NOTES.

ON Tuesday afternoon an important meeting was held in the Town Hall, Manchester, in support of the National Association for the Promotion of Technical Education. A powerful and most interesting address was delivered by Prof. Huxley. Afterwards, in accordance with a resolution moved by Sir H. E. Roscoe, and seconded by Sir W. H. Houldsworth, the meeting appointed an influential Committee to consider the proposals communicated by the National Association for the Promotion of Technical Education, and to take action thereon. Now that the vital importance of the subject is beginning to be understood in the district, there can be little doubt that Manchester will soon be supplied with a thoroughly sound and adequate system of technical instruction. The residuary legatees under the will of the late Sir Joseph Whitworth have just presented to the town a plot of land, called Potter's Park, which they have bought for £47,000. On a part of this land it is proposed that the following institutions shall be erected: (1) an appropriate Institute of Art, with galleries for paintings, for sculpture and moulded form, and for architectural illustration; (2) a comprehensive Museum of Commercial Materials and Products; (3) a Technical School on a complete scientific and practical scale. Much money will have to be provided before this scheme can be fully carried out, but in so great a centre of manufacturing and commercial energy the necessary funds should be raised without serious difficulty. The managers of the late Manchester Exhibition, like the Whitworth legatees, are vigorously supporting the movement, and their example will certainly be extensively followed. The progress made at Manchester is most satisfactory, and there are also many signs of an advance in the right direction at Liverpool and Newcastle.

THE latest news from Mr. John Whitehead is that he has returned from Palawan with a rich collection, especially in birds, of which he believes that he has obtained over eighty species not previously recorded from the island, and a large number of migrants. Palawan is an interesting place for a naturalist, as it lies so near the Philippine Archipelago, and yet contains a very strong Bornean element. Mr. Whitehead proposes shortly to make another ascent of Kina Balu Mountain, where last spring he obtained nineteen new species of birds, described by Mr. Bowdler Sharpe in the *Ibis* for October.

LETTERS have recently been received from Mr. H. O. Forbes, who is now at Granville in British New Guinea. He has not recovered from the overwhelming disaster at Batavia, when the whole of the *matériel* for his explorations was lost by the upsetting of a boat in the surf, but his spirits and those of his brave wife appear indomitable, and he hopes yet to proceed into the interior of New Guinea. He remarks that the Horse-shoe Range of the Astrolabe Mountains is unkown to residents in the island. This is the place whence Mr. Hunstein sent the wonderful birds of Paradise described by Dr. Finsch and Dr. Meyer, but Mr. Forbes says that he cannot find out the position of the range to which Hunstein attached the name. Mr. Forbes states that he has penetrated further inland than any other explorer, but that "no European foot has yet trod any portion of the real Owen Stanley Range." Surely some assistance can be rendered to this good naturalist, who has expended £2000 of his own money in the cause of science, to enable him to prosecute further researches. It only requires a glance at Mr. Forbes's work on the Malay Archipelago to show that he is a worthy follower in the footsteps of Wallace.

AT a dinner given by the Library Committee of the Corporation of London on Monday, Prof. Stokes responded for "Science." He said men of science knew how fascinating the pursuit of science was, even apart from its applications. It differed from art, however, in this respect, that when the scientific man had arrived at his result it was in very many cases of such a nature that only comparatively few men, who themselves had been trained more or less in science, could enter into and derive pleasure from it.

THE discussion on Sir Frederick Abel's paper on "Accidents in Mines," at the Institute of Civil Engineers, came to a conclusion on Tuesday evening, the debate having extended over four meetings, a number of well-known colliery owners and managers coming up from the country to take part in it. Safety-lamps, gas, coal-dust, winding-gear, and other topics were exhaustively discussed, and it was evident that amongst practical men a considerable difference of opinion exists on many of the questions raised. Sir Frederick having directed attention to the communication in NATURE, vol. xxxvi. pp. 437 and 438, Mr. Harries gave further particulars bearing upon the meteorology of colliery explosions. He showed how the popular belief that disasters are always accompanied by a low barometer is fostered by English and foreign newspaper reporters and writers habitually making statements on the subject which cannot be justified by the facts. Very few of the explosions of 1886 and 1887 have been coincident with a low barometer, and out of the list of disasters in the eleven years 1875–85 given by Sir Frederick Abel only 18·75 per cent. of the accidents, and 17·4 per cent. of the deaths, occurred when the mercury was at 29½ inches or below. One half of this small percentage of explosions took place with a low but rapidly rising barometer, and at a time when gas is shown by careful observations to have commenced issuing from the strata. The importance of studying the influence of anticyclones in connection with mining was still further emphasized, as coal-dust is more inflammable and more difficult to moisten when the air is cold and dry than in the time of cyclones, when the air is warm and damp. In the new rooms recently added to the Institute, an interesting series of appliances for use in mines was on exhibition, a number of safety-lamps of different patterns, oil and electric, the Fleuss apparatus, Loeb's respirator, safety winding-gear, anemometers, and a collection of photographs of miners actually at work, hewing, timbering, &c., from Mr. Sopwith, Cannock Chase.

MR. GOSCHEN will deliver his inaugural address as President of the Royal Statistical Society on Tuesday, December 6, when the first ordinary meeting of the present session will be held. The Statistical Society usually holds its meetings at the Royal School of Mines in Jermyn Street; but on the present occasion, as the Council have reason to expect an extra large attendance of the Fellows and their friends, it has been arranged that the meeting shall take place at Willis's Rooms, King Street, St. James's, at the usual hour, 7.45 p.m.

WE regret to have to record the sudden death of Dr. Max Schuster, Privat-docent and Assistant in the University of Vienna. His laborious researches on the optical characters of the Felspars are known to every petrologist; and his treatise on the features of Danburite, in its almost painful minuteness of observation and calculation, is one of the seven wonders of modern crystallography. His kindliness of manner, and his enthusiasm,

won him the affection and esteem of all who had the good fortune to know him: by his death, at the early age of thirty, Mineralogy is deprived of the most promising of its investigators.

DR. GUSTAV THEODOR FACHNER, the well-known physicist, died at Leipzig on November 18. He was born near Moscow, on April 19, 1801.

NATURALISTS have learned with much satisfaction that Mr. William Davison has been appointed to the Curatorship of the Singapore Museum. Mr. Davison's appointment has been objected to on the score that he is a "mere collector," but, even if this were the case, it would scarcely be denied that he is one of the best collectors ever known. Certainly he is without a rival in the present day, and only Wallace or Bates or Clarence Buckley could be named along with him. Such objectors, however, are singularly ignorant of Mr. Davison's career. For thirteen years he was Curator to Mr. Allan Hume, whose private museum was one of the best managed in the world, and he has conducted some of the most important scientific expeditions of modern times. At Singapore he will have the opportunity of completing his explorations in Malacca, which he commenced some ten years ago, when he traversed the whole of the western half of the peninsula, but was not able to penetrate to the mountainous regions of the eastern half. A rich field of discovery awaits him, if we may judge from the collections sent by Mr. Wray to the British Museum from the Larut Range behind Perak. Every naturalist may depend upon the hearty co-operation of Mr. Davison in any branch of science, and we shall expect to see that, in the course of a few years, Singapore possesses one of the most famous natural history collections in the East.

ON Saturday last Mr. Francis Galton gave at the South Kensington Museum the first of three lectures on heredity and nurture. Towards the close of the lecture Mr. Galton spoke of the advantages which might be derived from the establishment of a permanent anthropometric laboratory. An anthropometric laboratory is a place where a person may have any of his various faculties measured in the best possible way, at a small cost, and where duplicates of his measurements may be preserved, as private documents for his own future use and reference. Such an institution would contain apparatus both of the simpler kind used for weighings and measurings, and for determinations of chest capacity, muscular strength, and swiftness, and that of a more delicate description, used in what is technically called psycho-physical research, for determining the efficiency of each of the various senses and certain mental constants. Instruction might be afforded to those who wished to make measurements at home, together with information about instruments and the registration of results. An attached library would contain works relating to the respective influences of heredity and nurture. These would include statistical, medical, hygienic, and other memoirs in various languages, that are now either scattered through our different scientific libraries or do not exist in any of them. Duplicates of the measurements, but without the names attached, would form a growing mass of material accessible to statisticians. From conversation with friends, Mr. Galton gathers that the library might fulfil a welcome purpose in becoming a receptacle for biographies and family records, which would be in two classes—the one to be preserved as private documents, accessible only to persons authorized by the depositor; and the other as ordinary books, whether they were in manuscript or in print. Mr. Galton will be grateful for any communications that may show whether sufficient interest really exists to justify a serious attempt to found an Anthropometric Laboratory and Family Record Office, as well as for any helpful suggestions towards the better carrying out of the idea.

COMPARING the proceedings of the Anthropological Sections of the British and American Associations for the Advancement of Science, the American journal *Science* decides that the anthropological work done in the English institution is superior to that of the Americans. "We do not mean to say," it states, "that there are no vague theories held by British men of science, or that no eminent work is done by Americans; but the favourite studies of ethnologists as a whole, and as expressed in the subjects of papers presented to the English Association, seem to be of a more general and of a higher scientific character than they are here."

IN a recent number of the *Korrespondenzblatt* of the German Society for Anthropology and Ethnology, there is a good account of the archæological explorations which have been carried on near Reichenhall, in the south-eastern part of Bavaria. An ancient cemetery was discovered here some time ago, and no fewer than eighty-five skulls have been found, with some well-preserved skeletons, and a great quantity of weapons and ornaments. The skulls are of the primitive Germanic type, and the skeletons show that the people must have been about the size of the existing population of the Bavarian highlands. Among the treasures which have been recovered is a thin gold coin, evidently an imitation of a Roman coin. This coin probably belongs to the fifth century, and it may have found its way to this part of Germany in consequence of the intimate relations which are known to have existed between the ancient inhabitants of Bavaria and the Langobardi.

AN interesting account of a series of experiments upon the so-called alloy between the metals sodium and potassium is given by M. Joannis in the current number of the *Annales de Chimie et Physique*. For some years it has been known that, although in many respects so similar, these two metals possess a certain affinity for each other, and unite under suitable circumstances to form a liquid amalgam-like substance. M. Joannis has at length shown that a definite compound, NaK_2, is formed with considerable evolution of heat when the fused metals are brought together in the right proportion. In order to prove this fact, thermo-chemical methods were resorted to, liquid mixtures of the composition Na_2K, NaK, NaK_2, and NaK_3 being successively introduced into the calorimeter. The hydrogen liberated by decomposition of the water in the calorimeter was caused to pass first through a perforated platinum plate, and afterwards through a long thin-walled glass spiral, eventually escaping in minute bubbles through the water itself, after becoming reduced to the temperature of the calorimeter. The liquid mixture of metals was gradually introduced by means of an ingenious apparatus consisting of a drawn-out delivery-tube containing the alloy between two layers of protecting naphtha, and which, by means of a valve, could be placed in communication with a reservoir of compressed air, so that, by regulating the valve, a gentle stream of the liquid could be forced out as required. When the calorimetrical experiments were concluded, the amount of alkali was determined in an aliquot part of the water in the calorimeter, and thus the amount of metal used could be arrived at. From the data afforded by these experiments, M. Joannis appears to have conclusively shown that the only stable compound is NaK_2, all others being mixtures of this with excess of one or other of the two metals. It is very satisfactory that a reliable method has at last been found of distinguishing between true compounds and physical mixtures of metals, and rather remarkable that one of the earlier analyses of the most stable combination of sodium and potassium gave as the percentage of potassium 76·5, a number which closely approximates to that required for NaK_2.

SINCE the Ben Nevis Observatory was opened four years ago, eleven cases of St. Elmo's fire have been recorded. These case

have been examined by Mr. Rankin, first assistant, and compared with the other observations made from thirty hours previous to eighteen hours subsequent to the times of occurrence. It would appear that the phenomenon has almost invariably occurred when the temperature, after having been for some time distinctly above the mean of the season, has been falling for about twenty-four hours. During this time, while the temperature fell, the barometer also continued to fall till within three hours of the time of St. Elmo's fire, and thereafter rose steadily. The wind is west-south-westerly till the barometer falls to the minimum, and then shifts to north-west. The accompanying weather is fog, squalls, and unusually large-sized soft hail. Mr. Rankin further compared the phenomena with the weather charts of the Meteorological Office, with the result that pressure was in all cases highest over the south-west and south of Europe, diminishing, however, gradually towards North-Western Europe, where pressure was comparatively low, with several satellite cyclones skirting the northern coasts of the British Islands. Of the eleven cases, two occurred in September, three in October, four in November, one in January, and one in February.

THE Meteorological Report of the Straits Settlements for the year 1886 has been issued. Charts are appended, showing the mean annual elements from 1870 to 1886.

DR. A. MÜTTRICH has published the twelfth Annual Report of the forest meteorological observations of Germany. The stations now number sixteen, and the observations of temperature, &c., are made in the open, in the forests, and in the crowns of the trees. Monthly and yearly *résumés* are given, but there is no discussion of the results. Special attention is paid to evaporation and rainfall.

SEVERAL earthquakes are reported from Carinthia and Styria. On November 14 a shock was felt at Klagenfurt at 10 p.m., which lasted for four seconds. At Bleiburg, as well as over the whole of Carinthia, severe oscillations were noticed. Reports state that shocks occurred at 11 p.m. at Graz and Saldenhofen, and at 4 p.m. at Ostrau-Witkowitz. At Cavaillon and St. Saturnin-lès-Avignon (Vaucluse) oscillations were felt on November 14. At Cavaillon eleven houses were damaged. On November 17, at 8.55 a.m., two severe shocks occurred at Zafferana, near Etna. A severe earthquake, lasting for ten minutes, occurred in Iceland on October 28; at Reikianaes large chasms appeared in the ground.

The second session of the Liverpool Biological Society was opened on October 29, when Dr. J. J. Drysdale, the President, delivered an address on the definition of life as affected by the protoplasmic theory. The Council's Report showed the affairs of the Society to be in a very satisfactory condition, the number of members amounting to 121. At the second meeting of the session, held on November 12, the following papers, dealing with the history of the foundation of the Zoological Station on Puffin Island, Anglesey, were read: account of the foundation of the Station, and of the general work done during the past summer, by Prof. Herdman; report on the land Mollusca, by Alfred Leicester; report on the higher Crustacea, by A. O. Walker; report on the Actiniaria, by J. W. Ellis; report on the Copepoda, by J. C. Thompson; report on the Polyzoa, by J. Lomas.

AT a meeting of the Aristotelian Society on November 21, Dr J. McK. Cattell, of the University of Pennsylvania, read a paper on "The Psychological Laboratory of Leipzig." He explained how experimental psychology undertakes to analyze and measure mental phenomena, and advocated the systematic work of the laboratory, both for the education of students and for the advancement of knowledge. An account was then given of the psychological laboratory at Leipzig, founded by Prof. Wundt in 1879, and of the researches which have been undertaken in it, including experiments on the measurement of sensation, the duration of mental processes, attention, memory, and other subjects. The paper was followed by a discussion in which Prof. Bain, Prof. Dunstan, and others took part.

AN address on the Army Medical School, delivered some months ago by Sir Henry W. Acland, at Netley Hospital, at the distribution of prizes, has now been published. The author explains that he issues the address because of an opinion recently expressed before a Committee of the House of Commons by the Accountant-General of the Army, to the effect that the Army Medical School might be advantageously dispensed with. Sir Henry hopes that the Accountant-General of the Army may revise his opinion, and propose hereafter to increase the grant and to enlarge the scope and means of the school.

THE American Industrial Education Association is about to issue leaflets, giving concise information on points of its work regarding which questions are continually asked. The first leaflet will state compactly what the argument for manual training is.

IN a Report just published by the Foreign Office, on the trade of the Nyassa Territories, Mr. Hawes, the newly-appointed Consul, describes the Strophanthus, a climbing plant from which the natives extract a strong poison, and which is beginning to find its way into the London market. It is called by the natives *kombe*, and is found at a low level, and not apparently on high land. The supplies hitherto obtained have been drawn from the right bank of the Shire River below the Murchison Rapids. There is apparently more than one species, or at least variety, the distinguishing feature being a much smaller pod and fewer seeds. At present, information relative to the varieties is scant. It is a strong climbing plant, and is always found in the vicinity of high trees, on which it supports itself. The stem varies in diameter, but has an average of a few inches. It lies on the ground in folds, the branches supporting themselves on the nearest trees. The young branches are in appearance not unlike the elder. The fruit grows in pairs, and has a peculiar appearance, very like a pair of immense horns hanging to a slender twig. It begins to ripen in July, and lasts till the end of September. The native method of preparing the poison is very simple. They first clean the seeds of their hairy appendages, and then pound them up in a mortar until they have reduced them to a pulp. A little water is then added. This is done by using the bark of a tree containing a gummy substance, which helps to keep the poison on the arrow, in the event of its striking against a bone. The poison thus prepared is spread upon the arrow, and allowed to dry; game wounded by arrows poisoned with Strophanthus die quickly. The flesh is eaten without evil effect. The only precaution taken is to squeeze the juice of the baobab bark on the wound made by the arrow, and this counteracts the evil effects of the poison. Buffalo and all smaller game are killed by this poison.

THE additions to the Zoological Society's Gardens during the past week include a Cheetah (*Cynælurus jubatus*) from East Africa, presented by Mr. Frederick Holmwood; two White-backed Piping Crows (*Gymnorhina leuconota*) from Tasmania, presented by Mr. C. Sadler; a Crowned Hawk Eagle (*Spizætus coronatus*) from South Africa, presented by Mr. E. A. Hart; two Cereopsis Geese (*Cereopsis novæ-hollandiæ*) from Australia, presented by His Grace the Duke of Northumberland, P.C., K.G.; a Common Crossbill (*Loxia curvirostra*) British, presented by Mr. S. R. Armord; a Knot (*Tringa canutus*) British, presented by Mr. Howard Bunn; two Thunder Fish (*Misgurnus fossilis*) from the Baltic Sea; four Chub (*Leuciscus cephalus*) from British fresh waters, presented by Messrs. Paul and Co.; two Cape Crowned Cranes (*Balearica chrysopelargus*) from East Africa, a Mealy Amazon (*Chrysotis farinosa*) from South America, deposited.

OUR ASTRONOMICAL COLUMN.

Probable New Variables.—Mr. John Tebbutt calls attention in the *Observatory* for November to the double star OΣ 256, one of the components of which appears to be variable; for during the occultation of the star on August 22 the preceding component appeared very distinctly the brighter of the two, whilst Crossley and Gledhill, in their "Hand-book of Double Stars," regard this star as the companion. Struve was apparently the first to draw attention to the probable variability of this star, for whilst he usually estimated the preceding star as the brighter by half a magnitude, Dembowski recorded it as being the fainter by that amount.

Dr. Bauschinger (*Astr. Nach.* No. 2810), finds that a star in Libra, Lam$_3$ 1875, Munich Zones 695—place for 1855·0, R.A. 15h. 4m. 1·5s., Decl. 5° 27′·6 S.—is also probably variable. Lamont gives the star as of the eighth magnitude; Dr. Bauschinger finds it 9·2 m.; it is wanting in the southern Durchmusterung. Dr. Schönfeld writes that he observed the star on two, if not three occasions; once as 10 m. and once as 12 m. It should therefore be added in the *Bonn. Beob.* vol. viii., after − 5° No. 4028, as:—

"Var. 15h. 4m. 2·5s., 5° 27′·5 M."

Names of Minor Planets.—Minor Planet No. 268 has received the name of Adorea; No. 270 that of Anahita.

The Spectra of Oxygen and Carbon compared with that of the Sun.—Prof. Trowbridge and Hutchins have presented to the American Academy of Arts and Sciences a paper on the spectra of oxygen and carbon as compared with that of the sun. In the case of the former element, Dr. Henry Draper had convinced himself that there were bright lines in the solar spectrum corresponding to the bright lines of oxygen, whilst his brother, Prof. J. C. Draper, had identified the oxygen with faint dark lines, but the present experimenters conclude that "so far as concerns the spark spectrum in air and the solar spectrum from wave-lengths 3749·8 to 5033·85 they can safely affirm that there is no physical connection between them." They "have photographed the sun's spectrum every day that the sun has shone for nearly five months, without finding a line that could with certainty be pronounced brighter than its neighbours"; the powerful dispersion given by the large concave Rowland grating employed by Messrs. Trowbridge and Hutchins causing the "bright bands to vanish," which Dr. H. Draper thought he had discovered, and which seemed conspicuous with the dispersion he used, whilst it showed at the same time that there was no real correspondence between the oxygen lines and the dark lines Prof. J. C. Draper had identified with them. Lack of sufficient instrumental power had led both of the two earlier observers astray.

With regard to carbon, Messrs. Trowbridge and Hutchins are of opinion "that the fluted spectrum of carbon is an example of the reversal of the lines of a vapour in its own vapour," and they find a striking coincidence in many cases between the spaces separating the fine bright lines of the flutings and dark lines in the solar spectrum, twenty-eight such coincidences being traced within the limit of ten wave-lengths in the fluting at wave-length 3883·7. Their hypothesis as to the origin of the flutings leads them "to conclude that, at the point of the sun's atmosphere where the carbon is volatilized so as to produce the peculiar arrangement of reversals observed, the temperature of the sun approximates to that of the voltaic arc."

Olbers' Comet, 1887.—The following ephemeris for Berlin midnight for this object is in continuation of that given in Nature, vol. xxxvi. p. 588, and vol. xxxvii. p. 37, and is by Herr Tetens (*Astr. Nach.*, No. 2813):—

1887.	R.A. h. m. s.	Decl. ° ′	Log *r*.	Log Δ.	Brightness.
Dec. 1	15 26 36	7 10·9 N.	0·1594	0·3354	0·84
3	15 32 7	6 34·7			
5	15 37 31	5 59·5	0·1692	0·3417	0·78
7	15 42 49	5 25·1			
9	15 48 0	4 51·6	0·1790	0·3478	0·73
11	15 53 4	4 19·1			
13	15 58 2	3 47·5	0·1890	0·3537	0·68
15	16 2 54	3 16·9			
17	16 7 41	2 47·2 N.	0·1990	0·3593	0·63

The brightness on August 27 is taken as unity.

A Vienna observation of October 21 gives the error of the ephemeris as R.A. + 3s. and Decl. + 0′·2, and this will probably slowly increase.

ASTRONOMICAL PHENOMENA FOR THE WEEK 1887 DECEMBER 4–10.

(For the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)

At Greenwich on December 4

Sun rises, 7h. 50m.; souths, 11h. 50m. 19·6s.; sets, 15h. 51m.: right asc. on meridian, 16h. 42·2m.; decl. 22° 15′ S. Sidereal Time at Sunset, 20h. 44m.

Moon (at Last Quarter on December 8, 3h.) rises, 18h. 39m.*; souths, 2h. 44m.; sets, 10h. 44m.: right asc. on meridian, 7h. 34·0m.; decl. 20° 0′ N.

Planet.	Rises. h. m.	Souths. h. m.	Sets. h. m.	Right asc. on meridian h. m.	Declination on meridian ° ′
Mercury..	5 46	10 27	15 8	15 18·9	15 49 S.
Venus ...	3 20	8 45	14 10	13 36·7	7 36 S.
Mars ...	0 53	7 8	13 23	11 58·9	2 8 N.
Jupiter ...	5 56	10 27	14 58	15 18·9	17 25 S.
Saturn ...	19 57*	3 45	11 33	8 35·1	19 6 N.
Uranus ...	2 35	8 9	13 43	13 0·6	5 46 S.
Neptune..	15 11	22 52	6 33*	3 45·8	18 5 N.

* Indicates that the rising is that of the preceding evening and the setting that of the following morning.

Occultation of Star by the Moon (visible at Greenwich).

Dec.	Star.	Mag.	Disap. h. m.	Reap. h. m.	Corresponding angles from vertex to right for inverted image. ° °
6	7 Leonis	6½	5 18	6 27	59 300

Dec.	h.	
4	11	Mercury in conjunction with and 1° 35′ north of Jupiter.
5	5	Saturn in conjunction with and 0° 51′ north of the Moon.
5	8	Mercury at greatest elongation from the Sun, 21° west.
9	5	Mars in conjunction with and 2° 10′ south of the Moon.

Saturn, December 4.—Outer major axis of outer ring = 44″·3; outer minor axis of outer ring = 14″·2; southern surface visible.

Variable Stars.

Star.	R.A. h. m.	Decl. ° ′			h. m.	
U Cephei	0 52·3	81 16 N.	Dec.	7,	0 46	*m*
R Sculptoris	1 21·8	33 8 S.	,,	10,		*M*
Algol	3 0·8	40 31 N.	,,	6,	2 46	*m*
			,,	8,	23 35	*m*
λ Tauri	3 54·4	12 10 N.	,,	7,	2 17	*m*
S Orionis	5 23·4	4 47 S.	,,	7,		*M*
ζ Geminorum	6 57·4	20 44 N.	,,	9,	19 0	*m*
R Canis Majoris	7 14·3	16 11 S.	,,	8,	20 56	*m*
			,,	10,	0 12	*m*
T Cancri	8 50·2	20 17 N.	,,	6,		*M*
S Virginis	13 27·1	6 37 S.	,,	9,		*M*
U Coronæ	15 13·6	32 4 N.	,,	7,	23 4	*m*
β Lyræ	18 45·9	33 14 N.	,,	5,	4 0	*m*
S Vulpeculæ	19 43·8	27 0 N.	,,	7,		*M*
Y Cygni	20 46·8	34 10 N.	,,	5,	22 23	*m*
			,,	8,	22 17	*m*
R Vulpeculæ	20 59·4	23 22 N.	,,	5,		*m*
δ Cygni	22 25·0	57 50 N.	,,	6,	23 0	*M*

M signifies maximum; *m* minimum.

Meteor-Showers.

	R.A. °	Decl. °	
Near γ Persei	44	56 N.	Very slow; faint.
The Taurids II.	80	23 N.	Slow; bright.
The Geminids	107	33 N.	Swift; short.
Near δ Geminorum	110	24 N.	Rather swift.
Near π Leonis	145	8 N.	Swift; streaks.
Near β Ursæ Majoris.	162	58 N.	Very swift; streaks.

GEOGRAPHICAL NOTES.

In the *Bulletin* of the California Academy of Sciences for June, Mr. C. M. Richter re-examines all the data relating to the ocean currents contiguous to the coast of California, with the result that existing charts are in many cases found to be wrong, and that great diversity of opinion exists as to the real character and origin of these currents.

In the new number of the *Mouvement Géographique* the various rumours that have been afloat as to disasters which have happened to Mr. Stanley's Expedition are examined, and, when tested by known facts and the latest trustworthy information from Mr. Stanley himself and his officers, are shown to be without justification.

Mr. Montagu Kerr sailed from London last Thursday for Zanzibar, for the purpose of attempting to cross Africa by a new route. It is a mistake to refer to Mr. Kerr's private expedition as intended for the further "relief" of Emin Pasha. It has nothing whatever to do with Emin Pasha; though, no doubt, Mr. Kerr will shape his course through Masai Land towards Wadelai as his first stage, and may be guided by Emin's advice as to his further course. His main object after reaching Wadelai will be to proceed in a north-westerly direction towards Lake Chad, solving as far as possible by the way the hydrography of the Welle and Shari regions. After exploring around Lake Chad, Mr. Kerr may make for the Niger, though it is possible enough he will go on northwards in the direction of Tripoli. Since his return from his South African journey, Mr. Kerr has been diligently qualifying himself for scientific observation.

The paper on Monday at the Royal Geographical Society was one of unusual originality; it described Mr. A. D. Carey's two years' journey around and across Turkistan and into the north of Tibet. Mr. Carey, who was accompanied by the well-known Central Asiatic traveller, Mr. Dalgleish, describes so many new features that it is impossible to follow his route throughout on any map. Although his route coincided to some extent with those of Prejevalsky, he has been able to supplement the Russian traveller's observations in many directions. Mr. Carey, starting from Leh in Ladak, crossed the western part of Tibet and the western continuation of the Altyn Tagh, to Kiria in the south-west corner of the great Tarim Desert. Thence along the Khoten River he reached the Tarim, the course of which he followed, with excursions to various places on the route, as far as Lob Nor. The hydrography of this interesting river Mr. Carey has helped considerably to clear up. Some time was spent about the Lob Nor region, and then Mr. Carey, amid many difficulties, endeavoured to penetrate as far as possible into Tibet; but as his time was limited he did not succeed in getting further than the Ma Chu, about half-way between the Kuen Lun and the Tangla Range. But in his wanderings to and fro in the great marshy and desert plain that lies between the Altyn Tagh Mountains and the Kuen Lun, he has added something to our knowledge of one of the most interesting regions of Central Asia. From the Ma Chu, Mr. Carey struck almost direct northwards by Sachu to Hami, across the Gobi Desert. Then by a great sweep he traversed the northern border of Turkistan, by Turfan, Karashahr, Kuchir, Aksu, and Yarkand, back to Leh, two years after he left it. As he says, he thus completed the circuit of Chinese Turkistan, and, Kashgar excepted, visited every important place in it. The chief characteristic of the country is its extreme poverty. It may be described as a huge desert fringed by a few small patches of cultivation. The only really good strip of country of considerable size is the western portion, comprising Kargalik, Yarkand, and Kashgar. To the north a succession of very small oases extends along the foot of the Tian Shan Mountains, the stretches of intervening desert becoming longer as the traveller goes further to the east. The eastern extremity of the province is desert pure and simple, and so is the southern extremity as far west as Kiria, with the exception of the small oases of Charchand and Chaklik. The central portion is chiefly desert, except along the Tarim and in the Lob Nor region. Mr. Carey gives some useful notes on the different classes of people he met with, and occasionally a jotting on the natural history of the region. But the chief scientific result of Mr. Carey's journey is the excellent map which Mr. Dalgleish carefully plotted every day, and which covers many sheets; it is being reduced, and will be published by the Royal Geographical Society.

The correspondence from Major Barttlet, Mr. Stanley's second in command, from his station on the Aruwimi, shows that all is going well, and that if there are any dangers they will be due to the Arabs, and not to the natives. For the many rumours of disaster to the Expedition there is no foundation in fact; there is positively no news from Mr. Stanley since he left the Aruwimi, and in this case no news is good news, for bad news travels as rapidly in Africa as elsewhere.

THE ANNIVERSARY MEETING OF THE ROYAL SOCIETY.

The Royal Society held its Anniversary Meeting yesterday for the purpose of electing officers and presenting medals. The President delivered the address which we print below. After the meeting the Fellows dined together at Willis's Rooms, and the attendance was larger than on any previous occasion, nearly 200 Fellows being present.

During the past year death has removed from us fifteen of our Fellows and one foreign Member. It is remarkable that no less than six of these had reached the age which the Psalmist takes for the extreme duration of human life, while the average age of the whole exceeds seventy-five years. Within two months after our last anniversary Sir Joseph Whitworth died, at the age of eighty-four. Starting from a humble beginning, he attained, through his talent and steady application, a commanding position among constructors of machinery and heavy ordnance, and the truth of surface and accuracy of dimensions of what came from his workshop are probably unrivalled.

Sir Walter Elliot, who was still older, combined a high official position in India with the pursuit of natural history, and was the author of several papers in scientific serials. John Hymers and Thomas Gaskin were mathematicians well known to Cambridge men of some standing, and were both elected Fellows of our Society nearly half a century ago. The former was the author of various mathematical text-books, which for a long time were those chiefly used in their respective subjects by Cambridge students for mathematical honours. The latter, once a colleague of my own in a mathematical honour examination, was famed for his skill in the solution of problems, though he has not left much behind him in the way of mathematical writings, beyond a book containing the solution of a variety of problems. In Robert Hunt we have lost an aged Fellow whose name is well known in connection with the study of the action of light in producing chemical changes, and on vegetation. In Joseph Baxendell we had a man who during a long life was a diligent observer of astronomical and meteorological phenomena. John Arthur Phillips, a geologist who attended most particularly to the chemical origin of mineralogical and geological phenomena, was the author of several papers, some of which appeared in our own Proceedings. It is not long since Sir Julius von Haast was among us, apparently in full vigour, having come to England in connection with the Colonial Exhibition, and now this distinguished geologist and naturalist is no more. The Earl of Iddesleigh was suddenly carried off in the midst of the duties belonging to an important office in the State, whilst Beresford-Hope has succumbed to an illness of some duration. These two joined us under the statute which enables the Council to recommend to the Society for election, in addition to the fifteen who are selected in the ordinary way, and nearly always on account of their scientific claims, persons who are members of Her Majesty's Most Honourable Privy Council, and whose ability is thus attested, though they are not usually men of science. From the list of foreign Members, one name has disappeared which has become a household word among the physicists of all civilized nations. The name of Kirchhoff will ever be remembered as that of the introducer, conjointly with Bunsen, of spectral analysis into the regular work of the chemical laboratory, a step which has been so fertile in results. To him too we owe the reference of the dark lines of the solar spectrum to the absorption of portions of light coming from deeper portions of the sun by the vapours of substances which in the condition of incandescent vapour themselves emit bright lines in corresponding positions; and to him therefore we are indebted for the detection of chemical elements in the sun and stars, though partial anticipations of these discoveries had been made by others. The fertility of these researches, and the attention which they consequently excited, should not make us

forget the many important investigations in mathematical physics of which Kirchhoff was the author.

The present year is memorable as the Jubilee of the reign of Her Most Gracious Majesty our beloved Sovereign, and the Patron of our Society. An address of congratulation on this auspicious event was prepared by the Council, and was graciously received by Her Majesty in Windsor Castle at the hands of your President, who was accompanied on that occasion by the senior Secretary.

It happens that this same year is also the Jubilee of the Electric Telegraph, if we date from the first construction of a telegraph on an actually working scale, as distinguished from preparatory experiments made only in the laboratory. The Jubilee was duly celebrated by the Society of Telegraph Engineers. The name of our former Fellow Wheatstone will go down to posterity as having occupied a foremost place in this great practical application of Oersted's fertile discovery.

I will just briefly allude to another outcome of scientific research. The last half-century was well advanced when our Fellow Dr. Perkin, by utilizing a colour reaction which had been employed by chemists as a test for aniline, laid the foundation of the industry of the coal-tar colours, which has now attained such great proportions, and the investigation of the chemical theory of which has occupied the attention of so many eminent chemists from our own Fellow Dr. Hofmann onwards.

There is yet another Jubilee connected with this same year in which our Society is if possible still more closely connected: it is now just 200 years since the publication of the first edition of that immortal work, "The Principia" of Newton. Some of the important results embodied in the Principia had previously been communicated to the Royal Society.

But, restricting our view to the last half-century alone, we can hardly help casting a glance at the progress of science, and of the practical applications of science, within that period. In electricity, I have already referred to the electric telegraph, now passed into the management of a department of the State, and inwoven in our daily life, with its wires stretching all round the earth like the nerves in the body, and placing us in immediate connection with distant countries. Much more recent than the invention of the electric telegraph is that, in some respects, still more wonderful apparatus for communication at a distance afforded by the telephone. The application of electricity to lighting purposes, of which we have availed ourselves for the lighting of the apartments of our own Society, is an industrial outcome of Faraday's discovery of magneto-electric induction which could not have been thought of when the account of that discovery first appeared in our Transactions. It is true that what I have just been mentioning with respect to electricity consists of industrial applications rather than the discovery of new scientific principles; but these industrial applications react upon abstract science beneficially in more ways than one. The possibility of useful applications induces theorists to engage in investigations which they might not otherwise have thought of, the result of which is oftentimes to lead them to a clearer apprehension of fundamental principles, and to induce them to undertake exact quantitative determinations of fundamental constants. Moreover, the grand scale on which apparatus for actual commercial use has to be constructed renders it possible for scientific men, through the courtesy of those who direct the construction, to make interesting experiments on a scale the cost of which would be quite prohibitory if it were a matter of science pure and simple. Take for example the experiments made by Faraday on the first cable prepared for the attempt to span over the Atlantic Ocean.

When we think of the progress of science, both abstract and applied, during the last half-century, we can hardly help speculating as to the possible increase of scientific knowledge half a century hence. Perhaps we might be tempted to think that the mine must have been so far worked that no great quantity of precious ore can still be left, except what lies too deep for human power to extract. Yet surely the progress of knowledge in the past warns us against any hasty conclusion of the kind. How often have accessions to our knowledge been made which were quite unforeseen and quite unexpected, and how can we say what great discovery may not be made at any moment, and what a flood of light may not result from it?

In what direction such discoveries may be made, it would be rash indeed to attempt to predict. Yet one cannot help thinking of one or two cases in which we seem almost in touch of what if we could reach it would probably give us an insight into the processes of Nature of which we have little idea at present. Take for example the theory of electricity as contrasted with the theory of light. In the latter we have the laws of reflection and refraction, which have long been known, the remarkable phenomenon of interference, the curious appearances which we designate by phenomena of diffraction. But all these fall in the most simple and natural way into their places when we have arrived at the answer to the question, What is light? which is furnished by the statement, Light consists in the undulations of an elastic medium. But we are not at present able to give a similar answer to the question, What is electricity? The appropriate idea has yet to be found. We know a great deal about its laws, and its connection with magnetism and chemical action; we are able to measure accurately physical constants relating to it; we make it subservient to the wants of daily life; and yet we are unable to answer the question what is it? Could we only give a definite answer to this question, it seems likely that the production of electricity by friction, electrostatic attractions and repulsions, the laws of electrodynamics, those of thermodynamics, the nature of magnetism, and magneto-electric phenomena would prove to be all simple deductions from the one fundamental idea. Nay more: so closely is electricity related to chemical action, that could we only clearly apprehend the nature of electricity, it seems not unlikely that an unexpected flood of light might be shed on chemical combination.

Let me refer to one other instance in which a large accession to our present knowledge seems not altogether hopeless. We know that when an electric discharge is passed through a given gas, or between electrodes formed of a given substance, an analysis of the spark reveals a usually complicated spectrum of bright lines characteristic of the chemical substances present. The arrangement of the lines in most cases seems capricious, while in other instances we have repetitions of lines, or else rhythmical flutings, indicative of law, though one of no simple character. There can be no reasonable doubt that the periodic times indicated by the bright lines seen in the spectrum are those belonging to the component vibrations of the chemical molecules themselves; and the appearance is just such as would be produced by a tolerably complex dynamical system vibrating under the action of internal forces of restitution. Now such a system may really be composed of two or more simpler systems, held together less firmly than the parts of one of the simpler systems; and the complex vibrations of the whole may be made up of those of the several simpler systems, modified, however, by their mutual connection, together it may be with others due to the mutual connection of the simpler systems regarded each as a whole. It is conceivable that relations of chemical composition may thus be pointed out even between substances which we deem elementary, and which from their great stability we may, perhaps, never be able actually to decompose.

But I must apologize for having taken up your time with speculations as to the future; I will turn now to some mention of the action of your Council during the past year, and of the progress made by Committees appointed by the Council.

In response to an invitation received from the Academy of Sciences of Paris, that the Society should be represented at the International Conference of Astronomers, which it was proposed should assemble in Paris, in the spring, for the purpose of deliberating about concerted action for obtaining a complete map of the starry heavens by means of photography, your Council requested the Astronomer Royal to represent the Society on that occasion. The Conference met, as it was proposed, last spring; and I believe that the English astronomers at least think that a good foundation has been laid for concerted action in that great undertaking.

As the Fellows are already aware from a circular which has been issued, the Council has decided to make a change in the mode of publication of the Philosophical Transactions. The average yearly volume is a good deal more bulky now than it was at the beginning of the century, and its size is such as not unfrequently to make it desirable to bind one volume in two. The sciences, moreover, which are represented in the Philosophical Transactions, divide themselves very naturally into two groups: mathematics, physics, and chemistry forming one, and the biological sciences the other. The Council has decided to issue the Transactions from henceforth in two series, corresponding to these two divisions, and a yearly volume will appear in each series. It is hoped that this arrangement will be conducive to an earlier publication, as the numeration of the pages in the two series can go on independently. The indi-

vidual papers will also be issued separately, so that Fellows who prefer receiving them in this way can have them as soon as they are printed. Moreover, the issue of the Transactions in two series will enable institutions that are concerned with one only of the two groups of subjects, and that are not on our list for free presentation, to purchase for their libraries the series devoted to that group, instead of going to the expense of procuring the whole Transactions.

I am happy to be able to announce that the publication of the *Challenger* Report is now nearly finished. Twenty-eight volumes, some in two parts, have now been published, and these are all in the Society's library.

The Krakatão Committee have now all but completed their labours. A vast amount of information on the phenomena related to that most remarkable volcanic explosion has been collected and digested, different branches of the inquiry having been taken up by different members of the Committee. An estimate has been made of the cost of publication of the Report, and the Council has decided that it should be published as a separate work, and has voted the sum required for publication. The printing of the volume is now far advanced, and in a very few weeks it will in all probability be in the hands of the public.

The reports of the observers of the total solar eclipse of August last year are now coming in. From inquiries I have made I am in hopes that they will all be in by the end of the year. It is obviously convenient that they should all be dealt with together, rather than appear in a scattered form for the sake of a slightly earlier publication of those which happen to be read first.

I mentioned in my last address that with respect to this eclipse the Council, acting in accordance with the recommendations of the Eclipse Committee, had decided to confine themselves to an expedition to Grenada, without attempting another to Benguela on the Western Coast of Africa, which if sent out from this country would have been a good deal more costly, and of which the success, judging by such accounts of the climate of Benguela and its neighbourhood as we could procure, seemed very doubtful. The Committee guaranteed, however, £100 towards the expense of a small expedition from the Cape in case Her Majesty's Astronomer at that place should be in a condition to organize one. Sir W. J. Hunt-Grubbe, the Admiral in command at that station, was prepared to render every assistance in his power. Ultimately, however, it was not found practicable to organize an expedition from the Cape, and so the English observations of the eclipse were confined to those taken at Grenada. I have heard that the day of the eclipse was fine at Benguela, but there were no astronomers of any nation there to take advantage of it. It may be doubted, however, whether, in spite of the fineness, the haze which is said to prevail so much on that coast at that time of year, might not materially have interfered with the observations.

The boring in the Delta of the Nile has been continued, by the favour of the War Office, under the able and zealous superintendence of Captain Dickinson, R.E. As I mentioned last year, the Committee thought it best to concentrate their efforts on a single boring until rock should be reached, or else a stratum of such a character as to show that the alluvial or drifted deposit had been got through. This result has not at present been obtained. The boring at Zagazig reached the depth of 324 feet, when the tube broke, and stopped for the time further progress. It is, however, a matter of interest and importance to know that the drift or deposit extends to so great a depth. Geologists attach so much importance to the prosecution of the inquiry that at the suggestion of the Delta Committee an application was made to the Government Grant Committee for a grant of £500, which was acceded to by the Committee. This sum would not suffice for the prosecution of the inquiry to the extent contemplated; but it was thought that with such a sum as a nucleus extraneous pecuniary assistance might be obtained from Societies or individuals specially interested in the inquiry, and the Council have authorized the Delta Committee to avail themselves of such aid.

The meetings of Council and Committees continue to be very numerous, and no less than twenty-two Committees and Sub-Committees have been at work during the session.

The number of papers communicated to the Society continues to increase. In 1884-85 the number was 93; in 1885-86 it was 113; and in the past session, 129.

Since the last Anniversary one complete part of the Philosophical Transactions, and thirty-two papers towards the new volume have been published; the whole comprising no less than 1482 pages of letterpress and seventy-six plates. In the same period twelve numbers of the Proceedings, containing 984 pages, have appeared.

The task of preparing the MS. of the Catalogue of Scientific Papers, decade 1874 to 1883, has proved far heavier than was anticipated, and the matter very far exceeds in bulk that of the previous decade. The cataloguing of papers from the volumes in our own library has long been finished, but the work of gleaning stray papers from works in other libraries which we do not possess has proved more arduous than was expected, and even now is not quite completed. It is confidently hoped, however, that the MS. will be completed for the press during the coming session.

The distribution and exchange of duplicates from our library commenced last session has been continued, and several defective series among the periodicals on our shelves have been made good. The general work of the library has received careful attention at the hands of Mr. Alfred White, who shortly before the last Anniversary was appointed to the office of Assistant Librarian.

The Copley Medal for the year has been awarded to the eminent botanist, your former President, Sir Joseph Dalton Hooker. It is impossible, within the limits to which I must confine myself on the present occasion, to do more than briefly refer to some of the more salient features of his scientific career, extending as it does over nearly half a century of unceasing intellectual activity; and I need hardly say that in attempting to give some idea of important labours which lie outside my own studies, I am dependent on the kindness of scientific friends.

As a traveller, he can perhaps only compare with Humboldt in the extent to which he has used travel as an instrument of research. To quote a remark by Prof. Asa Gray, "No botanist of the present century, perhaps of any time, has seen more of the earth's vegetation under natural conditions" His Antarctic voyage in 1839-43 supplied the material for a series of well-known works of first-rate importance on the vegetation of the southern hemisphere; and these in their turn formed the basis of important general discussions. The journey to India in 1847-51 yielded, in the Himalayan journals, as Humboldt has remarked, "a perfect treasure of important observations." The maps made of the passes into Tibet are even still unsuperseded. The fine work on the "Sikkim Rhododendrons" was at once a revelation to the botanist and to the horticulturist. His account of the glacial phenomena of the Himalayas supplied facts both to Darwin and to Lyell. A journey to Morocco in 1871 and a later visit to North America led to important conclusions on plant distribution.

Perhaps Sir Joseph Hooker's most important place in scientific history will be found in the rational basis upon which he placed geographical botany. De Candolle, while admitting the continuity of existing floras with those preceding them in time, still adhered in principle to the multiple origin of species. To quote a remark by Prof. Asa Gray, "De Candolle's great work closed one epoch in the history of the subject, and Hooker's name is the first that appears in the ensuing one." According to Lyell, "the abandonment of the old received doctrine of the 'immutability of species' was accelerated in England by the appearance in 1859 of Dr. Hooker's 'Essay on the Flora of Australia.'" This essay effected a revolution. It was quickly followed in 1860 by the classical essay on the "Distribution of Arctic Plants," and in 1886 by the Nottingham lecture on insular floras. The fact of widely *dissevered* localities for species, which De Candolle found an insuperable obstacle to abandoning the doctrine of multiple origin, has, in the hands of Hooker and A. Gray (as stated by Bentham), afforded the most convincing proof of the genetic relationship of the floras of which such species are components.

In systematic botany, Hooker has perhaps had no rival since Robert Brown. The "Genera Plantarum," the joint work of himself and his friend Bentham, and the "Flora Indica," to the completion of which our colleague is devoting the leisure of a well-earned retirement, form only as it were the head of an immense body of taxonomic memoirs.

Nor have his services to botanical science been confined to geographical botany and to taxonomy. His researches on various groups, such as *Welwitschia* and others, deal in a masterly way with morphological problems of the highest interest and of extreme difficulty.

While no one would attempt to minimize the commanding

and unique position of Mr. Darwin, the scientific historian of the future will recognize how much the development of the modern theory of evolution, from its first conception in the mind of Mr. Darwin, was facilitated by the interaction upon one another of the work and minds of Darwin, Hooker, and Lyell. It was due to the earnest efforts of his two friends that Mr. Darwin was induced to publish the first sketch of the origin of species at all. And no one, had he been alive, would have more cordially recognized than Mr. Darwin how vast an armoury of facts the wide botanical experience of Hooker constantly placed at his disposal in fortifying and supporting his main position.

Of the two Royal Medals, it is customary, though it is not an invariable rule, to award one for mathematics or physics, and the other for biological science.

The medal, which, in accordance with the usual rule, has been devoted to mathematics and physics, has this year been awarded to Colonel A. Clarke for his comparison of standards of length, and determination of the figure of the earth.

Colonel Clarke was for some twenty-five years the scientific and mathematical adviser for the Ordnance Survey, and whilst acting in that capacity he became known to the whole scientific world as possessing a unique knowledge and power in dealing with the complex questions which arise in the science of geodesy.

His laborious comparison of the standards of length, carried out under General Sir Henry James, R.E., are universally regarded as models of scientific precision.

His determination of the ellipticity and dimensions of the earth from the great arcs of meridian and longitude involved a very high mathematical ability and an enormous amount of labour. The conclusion at which he arrived removed an apparent discrepancy between the results of pendulum experiments and those derived from geodesy, and is generally accepted as the best approximation hitherto attained as to the figure of the earth.

The accounts of these investigations have been published in a number of memoirs, several of which have been communicated to the Royal Society.

In 1880 he published a book on geodesy, which, besides giving an accurate account of that science, embodies the main results of the work of his life.

In the biological division of the sciences the Royal Medal has this year been awarded to Prof. Henry N. Moseley for his numerous researches in animal morphology, and especially his investigations on Corals and on Peripatus.

The result of his elaborate investigations on Corals, an account of which has been published in the Philosophical Transactions, was to show that the Milleporidæ and the Stylasteridæ were not, as had been thought, Anthrozoan in nature, but were composite coral-forming hydroids. Many new genera and species were described by him in these memoirs, and in fact a new group of organisms, the Hydrocorallinæ, was not merely indicated, but the complete morphology and systematic subdivisions of that order were worked out.

Moseley's memoir on Peripatus is not less remarkable. He was the first to point out the true nature of this remarkable animal, and to demonstrate that it was in reality an archaic Arthropod. The subsequent investigations of Balfour and Sedgwick have further increased the importance of Moseley's discovery.

Moseley's memoir on the Land Planarians of Ceylon (Phil. Trans., 1872) is an important contribution to the anatomy of the Turbellaria. He was the first to apply the method of section-cutting to the Planarians, and his paper is full of new facts of great importance, which have stood the test of subsequent work over the same ground.

Besides these three great memoirs published in the Philosophical Transactions, Moseley has published numerous minor discoveries, and his spectroscopic observations on the colouring matters of marine organisms have proved the starting-point of valuable investigations.

Mention must not be omitted of Moseley's admirable book, "Notes of a Naturalist on the *Challenger*," which has been justly compared, for the varied ability, interest, and activity which it evinces on the part of the author, to Darwin's "Voyage of the *Beagle*."

Since the date of the works above referred to, Moseley has been chiefly active in the discharge of his duties as Linacre Professor, and the success with which he has directed the work of his pupils is evinced by the important memoirs on zoological subjects which several of them have produced whilst working under his direction. He has himself also published a remarkable discovery with regard to the Chitons. In the shells of many genera and species of these mollusks he has detected highly developed eyes, of which he has described the minute structure.

The Davy Medal for the year 1882 was awarded by the Council to Profs. Mendelejeff and Lothar Meyer conjointly, for their discovery of the periodic relations of the atomic weights. This relation, now known as "the Periodic Law," has attracted great attention on the part of chemists, and has even enabled Prof. Mendelejeff to predict the properties of elements at the time unknown, but since discovered, such as gallium for instance.

But while recognizing the merits of chemists of other nations, we are not to forget our own countrymen; and accordingly the Davy Medal for the present year has been awarded to Mr. John A. R. Newlands, for his discovery of the Periodic Law of the chemical elements. Though, in the somewhat less complete form in which the law was enunciated by him, it did not at the time attract the attention of chemists, still, in so far as the work of the foreign chemists above mentioned was anticipated, the priority belongs to Mr. Newlands.

SCIENTIFIC SERIALS.

Rivista Scientifico-Industriale, October.—On the crepuscular phenomena of 1883–84, by Prof. Annibale Riccò. These remarks are made in connection with the author's comprehensive work, now nearly ready for the press, on the remarkable after-glows of the years 1883–84. One of the chief conclusions arrived at in this work, after a careful consideration of all the evidence, is that the volcanic theory, first advanced by Mr. Norman Lockyer, is the only one that can be now accepted. The light-effects appeared soon after the great eruption of Krakatão on August 27, 1883, were propagated from the neighbourhood of the volcano to the most distant parts, and then gradually died out, precisely in the same way that similar manifestations were made immediately after the eruption of the island of Ferdinandea (Julia) in 1831. It is further concluded that the after-glows were due, not to the ashes or scoriæ ejected by Krakatão, but to the condensation of the aqueous vapours caused by the volcano, which condensation increased the quantity of solar light reflected by the atmosphere.

Bulletin de l'Académie Royale de Belgique, October.—On the mass of the planet Saturn, by L. de Ball. By a comparative study of its satellites, made at the Observatory of Cointe during the winter of 1885–86, the author finds the mass of Saturn to be 1/3492·8 that of the sun, which is rather less than the values obtained by Meyer, Hall, and Struve, which are 1/3482·5, 1/3481·3 and 1/3490·8 respectively.—Experimental researches on the sense of vision in the Arthropods, by Felix Plateau. Of this elaborate memoir the first part only appears in this issue, dealing first with the work already accomplished down to the year 1887 on the structure and functions of simple eyes; secondly, with the eyes of Myriapods. The four remaining parts, to be published in subsequent numbers of the *Bulletin*, will treat of vision in the spiders, and in larvæ generally; of the part played by the frontal eyes in perfect insects; of compound eyes and the perception of movements; with an anatomico-physiological summary, and experiments with insects.—Remarks on the total solar eclipse of August 19, 1887, by L. Niesten. A comparative study of the photographs obtained by MM. Niesten and Karelin at the station of Jurjewetz, shows that with Van Monckhoven's sensitive plates an almost instantaneous image is obtained not only of the protuberances but also of the corona; and further that a pose of thirty seconds gives no more detailed images of the corona than those obtained at the end of eight seconds. Hence it would appear that photographs of the corona obtained after an exposure of over a minute should be attributed to physical phenomena due to the atmospheric conditions, or to light-effects produced in the photographic apparatus itself.

SOCIETIES AND ACADEMIES.

LONDON.

Linnean Society, November 3.—W. Carruthers, F.R.S., President, in the chair.—Mr. J. H. Hart, of Trinidad, was elected a Fellow of the Society.—The President called attention

to the death-roll since last June meeting, specially deploring the loss of Prof. Julius von Haast, N.Z., Dr. Spencer Baird, U.S., and Prof. Caspary, of Königsberg.—Mr. H. N. Ridley gave an account of his natural history collection in Fernando Noronha. The group of islands in question is in the South Atlantic, 194 miles east of Cape San Roque. The largest is about five miles long and two miles across at broadest part. Although chiefly basaltic, phonolite rocks crop up here and there. The indigenous fauna and flora seem to have been much modified, and in some cases extirpated, by human agency. Of mammals, the cat is reported to have become feral, and rats and mice swarm; Cetacea occasionally frequent the coast. The land-birds comprise a dove, a tyrant, and a greenlet (*Virio*). Sea-birds are numerous, though apparently less so than in the time of the early voyagers. Among reptiles occurs an Amphisbæna, a Skink, and a Gecko; turtles also haunt the bays. The absence of batrachians and fresh-water fish is noteworthy. A well-known Brazilian species of butterfly is plentiful. Though insects generally are abundant, there are, notwithstanding, but few species. Two shells (*Trochus*) show a southern distribution, though other marine forms indicate West Indian relationship. Several interesting plants were got, a *Solanum* with medicinal properties, a new *Erythrium*, and flower of the "Burra," a Euphorbiaceous tree. Of ferns, mosses and hepatics, lichens and fungi, several interesting sorts were collected.—Mr. Geo. Murray exhibited *Vallonia ovalis* from Bermuda and Grenada; the former sort consisting of a balloon-shaped cell an inch long and two wide. He explained by diagrams the development of *V. utricularis*, incidentally comparing this with *Sciadium*.—Prof. Marshall Ward showed specimens and made remarks on the peculiar development of *Agaricus* (*Amillaria*) *melleus*.—Mr. E. A. Heath exhibited examples of fruits of two species of *Solanum* from Barbados.—A paper was read on the scars occurring on the stem of *Dammara robusta*, by Mr. S. G. Shattock. He says that the process of disarticulation of the branches is like that by which a leaf or other organ is shed. The parenchymatous cells across the whole zone of articulation multiply by transverse division, a layer of cork resulting from the formation of this secondary meristem, and through the distal limits of this, solution of continuity occurs. After this the slender connecting bond of wood is broken across by the weight of the branch or the first trivial violence; this completion of the process being aided, perhaps, by the tension made upon the wood in consequence of the cell-division of the surrounding parenchyma which occurs across its axis. It thus happens that the whole of the parenchymatous system of the stem is closed by cork *before* the branch is actually shed.—A communication followed, by Messrs. J. G. Baker and C. B. Clarke, on the Ferns of Northern India; it being a supplement to a memoir published in the Society's Transactions.

Physical Society, November 12.—Prof. W. E. Ayrton, F.R.S., Vice-President, in the chair.—Lieut. Bacon, R.N., was elected a member of the Society.—Owing to the illness of Dr. Shettle, the paper announced to be read by him was postponed. —The following communication was read:—On a geometrical method of determining the conditions of maximum efficiency in the transmission of power by alternating currents, by Mr. T. H. Blakesley. In this paper the author confines himself to the consideration of a simple circuit containing generating, conveying, and recipient parts, in which the E.M.F. follows the law of sines. The maximum E.M.F.'s of both machines are supposed known, together with the resistance and coefficient of self-induction of the complete circuit. The variable on which the efficiency of transmission depends is the difference of phase of generator and receiver. A geometrical construction is given by which the phase which gives maximum efficiency can be determined. Mr. Kapp thought the construction would not apply where the receiver does mechanical work, owing to the E.M.F. not being a true sine function of the time. He also mentioned an experiment performed on a motor driven successively by alternating and direct currents, in which the *apparent* power $\left(\sqrt{\overline{e^2}}\sqrt{\overline{c^2}}\right)$ supplied by alternating currents was about five times that required when direct currents were used, the motor giving out the same power in the two cases. From this he inferred that the ratio of power to weight is much greater for a direct than for an alternating current motor. This he considered a serious drawback to the use of alternate currents for transmitting power. After some remarks by Prof. Ayrton and Prof. S. P. Thompson, Mr. Blakesley said that by placing a condenser between the terminals of the recipient machine a greater current could be passed through the receiver than that in the generator and line.—Prof. A. W. Rücker exhibited and described a lecture experiment for determining the velocity of sound. The principle of the arrangement is that used by Fizeau in determining the velocity of light. A vibrating reed is used as the source of sound and a sensitive flame as receiver. A long U-shaped tube has its two ends placed near and parallel to the plane of a perforated disk, which is capable of rotating about an axis perpendicular to its own plane. The reed and sensitive flame occupy similar positions on the opposite side of the disk. On rotating the disk, the sensitive flame flares or is quiescent according as the time taken to travel the length of the tube is an even or an odd multiple of $\frac{T}{2n}$, where T is the time of one revolution and n the number of holes in the disk.—Mr. Bosanquet exhibited a form of polariscope he had made some time ago for researches on the polarization of the sky. Its chief feature is a compound prism of right- and left-handed quartz which shows coloured bands with polarized light, whatever be the direction of the plane of polarization. It also forms a very sensitive object for polarimeters.

Zoological Society, November 15.—Prof. W. H. Flower, F.R.S., President, in the chair.—The Secretary read a report on the additions that had been made to the Society's Menagerie during the months of June, July, August, September, and October, 1887, and called attention to certain interesting accessions which had been received during that period.—A communication was read from Herr W. von Nathusius, of Königsborn, on *Symbiotes equi*, a parasite of the horse, causing what is called "greesy-foot," of which he sent specimens for exhibition.—The Secretary read a letter addressed to him by Dr. Emin Pacha, dated Wadelai, April 15, 1887, referring to some communications which he was proposing to offer to the Society. —A letter was read from Surgeon-General George Bidie, referring to a case of the breeding of the Elephant in captivity.—Prof. Bell made some observations on the "British Marine Area," as proposed to be defined by the Committee of the British Association. Prof. Bell opposed the idea of omitting the Channel Islands from the British area.—Prof. A. Newton, F.R.S., exhibited (on behalf of Mr. W. Eagle Clarke) a specimen of Bulwer's Petrel (*Bulweria columbina*), believed to have been picked up dead in Yorkshire.—Mr. H. E. Dresser exhibited (on behalf of Lord Lilford) specimens of a new species of Titmouse allied to the Marsh-Tit (*Parus ater*), obtained by Dr. Guillemard in Cyprus, which he proposed to designate *Parus cypriotes*.—Mr. Boulenger exhibited a living specimen of a rare African Batrachian (*Xenopus lævis*), which had been sent to him by Mr. Leslie, of Port Elizabeth.—Prof. Flower exhibited a photograph of a specimen of Rudolphi's Whale (*Balænoptra borealis*), taken in October last, in the Thames near Tilbury.—Mr. G. A. Boulenger, read on account of the Reptiles and Batrachians collected by Mr. H. H. Johnston on the Rio del Rey, West Africa. Amongst these were examples of two species of Batrachians new to science. —Mr. Edgar A. Smith read some notes on three species of shells obtained by Mr. H. H. Johnston at the Rio del Rey, Cameroons. —Mr. A. G. Butler read a paper containing an account of two small collections of African Lepidoptera obtained by Mr. H. H. Johnston at the Cameroons and the Rio del Rey.—A communication was read from Mr. G. E. Dobson, F.R.S., on the genus *Myosorex*. The paper contained the description of a new species from the Rio del Rey (Cameroons) district, which he proposed to call *Myosorex johnstoni*, after Mr. H. H. Johnston, who had sent home the specimens.—Mr. G. A. Boulenger gave the description of a new species of *Hyla* from Port Hamilton, Corea, living in the Society's Gardens, which he proposed to name *Hyla stepheni*, after its discoverer.

Institution of Civil Engineers, November 8.—Mr. G. B. Bruce, the new President, after presenting the medals and premiums announced at the annual meeting in May last, delivered his address on assuming the chair for the first time. Having entered upon his apprenticeship in the locomotive works of Robert Stephenson within a few months of the beginning of the present reign, the President chose the state of engineering then and in the Queen's Jubilee year as the subject of his remarks. Starting with the workshop, in 1837 machine-tools were practically unknown, reliance being placed upon the skill of the workmen, who could chip and file by hand almost as truly as the machine. It was scarcely credible, but it was a fact, that there

was not a single crane in Robert Stephenson's shops in 1837; and the only steam-engine, in that which was the most important locomotive shop in the world of that day, was a vibrating pillar-engine, with a single 16-inch cylinder and 3-feet stroke. About the only machine-tool, properly so called, in the works was a planing-machine, which probably weighed about 3 tons. At the present time there were lathes 75 feet long, weighing 100 tons, giving a yield of steel-turnings at the rate of 10 and 20 tons a day, and planing-machines weighing 90 tons and operating over surfaces of 20 feet by 15 feet. Having spoken of the changes in the position of the workmen, the President referred to the progress of railways, the development of the iron and steel industries, and sanitary engineering. Reference was made to the electric telegraph, which had developed from the 5-needle instrument of Cooke and Wheatstone, employing six wires and working at about the rate of four words a minute, to the system of multiplex and automatic telegraphy, by means of which six messages could be sent at once on one wire with a speed of, say, 600 words per minute. Touching successively on the telephone, electric light, and the application of electricity as a motive power, the President hazarded the opinion that when some way should have been discovered of storing up in a more efficient and financially successful manner the unemployed forces of Nature, such as the winds and tides, then would electricity become a factor in the world's life compared with which it was at present as nothing.

Anthropological Institute, November 22.—Prof. Flower, C.B., Vice-President, in the chair.—Canon Isaac Taylor read a paper on "The Primitive Seat of the Aryans," in which he urged the view that the Finns are the nearest representatives of the ancient Aryan stock, and that the race took its origin in North Germany.

EDINBURGH.

Royal Physical Society, November 16.—Prof. Duns delivered the introductory address for the session 1887–88. At the outset obituary notices of several deceased Fellows were given, notably of Mr. Robert Gray, the late Secretary of the Society. After some remarks upon the history and progress of the Society, he passed on to consider the claims of Scotland upon Government aid for scientific purposes, and advocated the union of the various scientific corporations of Edinburgh to form an Academy of Science for dealing with general questions of this nature.

PARIS.

Academy of Sciences, November 21.—M. Janssen in the chair.—On the nervous system of the Gasteropods (Aplysia type, *A. depilans* and *A. fasciata*), by M. H. de Lacaze-Duthiers. The Aplysia, a large mollusk, abounding especially in the Mediterranean seaports, is here studied for the purpose of determining the type of its nervous system in order to compare it with those of Gadinia, Testacella, and other Gasteropods already described by the author.—Remarks in connection with M. Colladon's recent note on waterspouts and tornadoes, by M. H. Faye. It is again shown that M. Colladon's illustration, as published in the *Comptes rendus*, has only a very remote connection with true waterspouts and whirlwinds. Reference is also made to the statement, in W. Ferrel's new work on meteorology, that much sea-water is carried up by the ascending current of waterspouts, the fish and other animals in small ponds being even in this way borne aloft and wafted to great distances. On the contrary, M. Faye insists with Lieutenant Finley, of the United States Signal Service, that no appreciable quantity of water is pumped up in this way, although much is driven horizontally to the right and left by the gyratory velocity of the air, which has always a descending, and never an ascending motion.—On the crystalline form of cinchonamine, by M. C. Friedel. Some crystals of the alkaloid discovered by Arnaud in certain varieties of quinquinas are described as hexagonal prisms terminating in a rhombohedron and of the true orthorhombic type.—On a meteorite which fell on August 18/30, 1887, at Taborg, in the Government of Perm, Russia, by M. Daubrée. This meteorite, which has but slight cohesion, with density 3·620, appears to closely resemble those which fell on April 1, 1857, at Heredia (Costa Rica); on May 14, 1861, at Canellas, Province of Barcelona (Spain); on January 19, 1867, at Khethree, Rajputana (India); and on August 17, 1875, at Feid Shair (Algeria).—On a simple relation between the wave-lengths of spectra, by M. A. E. Nordenskjöld. The researches here described tend to confirm the author's previous view that, at least in the spectra of certain simple bodies, the differences between the logarithms of the wave-lengths of each element are simple multiples of the same number. The universality of this law, as applicable to the spectra of all bodies, is still far from being established. But further investigation will probably show, either that the spectra of all simple bodies conform absolutely to this law, or else that they are disposed in more or less independent groups, to which the law may still be applicable.—On the volcanoes of Hawaii, by Mr. James Dana. Reserving for the *American Journal of Science* a detailed account of a recent visit to these volcanoes, the author here remarks chiefly on the remarkable fluidity of the lavas, and on the fact that the eruptions show no sign of being in any way associated with the surrounding marine waters. The salts deposited in the hottest recesses, and those of solfataras, do not appear to have hitherto yielded any chloride, while the sulphate of soda is very common.—Researches on meteorites: general conclusions, by Mr. J. Norman Lockyer.—Observations of Olbers' comet (1815 I.), at its return in 1887, made with the 0.38 m. equatorial of the Bordeaux Observatory, by MM. G. Rayet and F. Courty. The observations cover the period from September 8 to September 25.—On sidereal evolution, by M. Stanislas Meunier.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

Die Welt in Ihren Spiegelungen unter dem Wandel des Völkergedankens. Prolegomena zu Einer Gedankenstatistik; Ethnologisches Bilderbuch mit Erklärendem Text: A. Bastian (Mittler, Berlin).—Sound, Light, and Heat: M. R. Wright (Longmans).—A Primary Geometry: S. E. Warren (Trübner).—Quantitative Chemical Analysis: Classen and Herrick (Trübner).—Myth, Ritual, and Religion: A. Lang (Longmans).—Translations of Foreign Biological Memoirs, I. Memoirs on the Physiology of Nerve, of Muscle, and of the Electrical Organ, edited by J. Burdon-Sanderson (Clarendon Press).—Earth Knowledge: Harrison and Wakefield (Blackie).—Colour: Prof. A. H. Church (Cassell).—Elementary Microscopical Manipulation: T. C. White (Roper and Drowley).—Quarterly Journal of Microscopical Science, November (Churchill).—Annales de la Faculté des Sciences de Toulouse, tome i., 1887, 4 parts (Gauthier-Villars, Paris).

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